HICKORY CREEK WATERSHED

STRUCTURE H-10D

SPECIFICATIONS

Covering Construction of the proposed works of improvement in Hickory Creek Watershed Flood Prevention Project. Structure H-10D is located on the south edge of Neosho in Newton County, Missouri.

Specifications referred to herein shall form a part of these Construction and Material Specifications and the Contractor shall exercise special care to refer to them in request for quotations, in orders, and in subcontracts. Materials so specified shall conform to the technical requirements of the respective specifications referred to.

HICKORY CREEK WATERSHED

STRUCTURE H-10D

INDEX OF CONSTUCTION SPECIFICATIONS

INDEX OF MATERIAL SPECIFICATIONS

CONSTRUCTION SPECIFICATION

2. CLEARING AND GRUBBING

1. SCOPE

The work shall consist of the clearing and grubbing of designated areas by removal and disposal of trees, snags, logs, stumps, shrubs and rubbish.

2. PROTECTION OF EXISTING VEGETATION

Trees and other vegetation designated to remain undisturbed shall be protected from damage throughout the duration of the construction period. Any damages resulting from the Contractor's operations or neglect shall be repaired by the Contractor.

Earthfill, stockpiling of materials, vehicular parking, and excessive foot or vehicular traffic shall not be allowed within the drip line of vegetation designated to remain in place. Vegetation damaged by any of these or similar actions shall be replaced with viable vegetation of the same species, similar condition, and like size unless otherwise approved by the Contracting Officer.

Any cuts, skins, scrapes or bruises to the bark of the vegetation shall be carefully trimmed and local nursery accepted procedures utilized to seal damaged bark.

Any limbs or branches one-half (1/2) inch or greater in diameter which are broken, severed or otherwise seriously damaged during construction shall be cut off at the base of the damaged limb or branch flush with the adjacent limb or tree trunk.

All roots one (1) inch or greater in diameter which are cut, broken or otherwise severed during construction operations shall have the end smoothly cut perpendicular to the root. Roots exposed during excavation or other operations shall be covered with moist earth and/or backfilled as soon as possible to prevent the roots from drying out.

3. MARKING

This limits of the areas to be cleared and grubbed will be marked by means of stakes, flags, tree markings or other suitable methods. Trees to be left standing and uninjured will be designated by special markings placed on the trunks at a height of about six feet above the ground surface.

4. CLEARING AND GRUBBING

All trees not marked for preservation and all snags, logs, brush, stumps, shrubs and rubbish shall be removed from within the limits of the marked areas. Unless otherwise specified, all stumps, roots and root clusters having a diameter of one inch or larger shall be grubbed out to a depth of at least two feet below subgrade elevation for concrete structures and one foot below the ground surface at embankment sites and other designated areas.

5 DISPOSAL

All materials removed from the cleared and grubbed areas shall be burned or buried at locations shown on the drawings or as specified in Section 7 of this specification. The contractor is responsible for complying with all local rules and regulations and the payment of any and all fees that may result from disposal at locations away from the project site.

6. MEASUREMENT AND PAYMENT

For items of work for which specific lump sum prices are established in the contract, payment for clearing and grubbing will be made at the contract lump sum price. Such payment shall constitute full compensation for all labor, equipment, tools and all other items necessary and incidental to completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

7. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 2, Clearing and Grubbing

(1) This item shall consist of clearing and grubbing scattered trees in the embankment, auxiliary spillway and outlet channel areas. Limits of the clearing grubbing will be as staked in the field by the Engineer.

(2) All timber removed from clearing and grubbing areas shall be burned. Large stumps and other remaining materials that are resistant to burning will be hauled to site H-1A and buried as approved by the government. Buried material shall have a minimum of 2 feet of soil cover.

(3) Payment will be made as the work proceeds after presentation of invoices by the Contractor showing his own clearing and grubbing costs and evidence of the charges of subcontractors, and others, for clearing work performed by them. If the total of such payment is less than the contract lump sum, the unpaid balance will be included in the first invoice following completion of the contract item. Total payment will be the lump sum contract price regardless of actual costs to the Contractor.

(4) Item of work subsidiary to this bid item is:

(a) Structure Removal, Construction Specification 3.

CONSTRUCTION SPECIFICATION

3. STRUCTURE REMOVAL

1. SCOPE

The work shall consist of the removal, salvage, and disposal of structures (including fences) from the designated areas.

2. MARKING

Each structure unit to be removed will be marked by means of stakes, flags, painted markers or other suitable methods.

3. REMOVAL

All structures designated in the contract for removal shall be removed to the specified extent and depth.

4. SALVAGE

Structures or structure parts that are designated to be salvaged shall be carefully removed and neatly placed in the specified or approved storage areas. Salvaged structures that are capable of being disassembled shall be dismantled into individual members or sections. Such structures shall be neatly and systematically match marked with paint prior to disassembly. All pins, nuts, bolts, washers, plates and other loose parts shall be marked or tagged to indicate their proper locations in the structure and shall be fastened to the appropriate structural member or packed in suitable containers. Materials from fences designated to be salvaged shall be placed outside the work area on the property from which they were removed. Wire shall be rolled into uniforms rolls of convenient size. Posts and rails shall be neatly piled.

5. DISPOSAL OF REFUSE MATERIALS

Refuse materials resulting from structure removal shall be burned or buried at locations shown on the drawings or as specified in Section 7 of this specification. Disposal by burning shall be in accordance with local rules and regulations.

6. MEASUREMENT AND PAYMENT

For items of work for which specific lump sum prices are established in the contract, payment for structure removal will be made at the contract lump sum price.

Such payment will constitute full compensation for all labor, equipment, tools, applicable permits and associated fees for burning and disposal of refuse, and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

7. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Subsidiary Item, Structure Removal - Miscellaneous

(1) This item shall consist of removing and disposing of the abandoned sewer line as shown on the drawings. Limits of sewer line removal shall be as staked in the field by the Engineer.

(2) Pipe and manholes removed shall be disposed of off-site in an approved landfill.

(3) No separate payment will be made for this item. Compensation for this item shall be included in the payment for clearing and grubbing.

b. Subsidiary Item, Structure Removal – Abandoned Utilities

(1) This item shall consist of removing and disposing of any remaining abandoned utilities as approved by the engineer. The sewer line is not included in this item.

(2) The Contractor shall have the City of Neosho mark all utilities on site prior to beginning construction.

(3) No separate payment will be made for this item. Compensation for this item shall be included in the payment for clearing and grubbing.

CONSTRUCTION SPECIFICATION

5. POLLUTION CONTROL

1. SCOPE

The work shall consist of installing measures or performing work to control erosion and minimize the production of sediment and other pollutants to water and air from construction activities.

2. MATERIALS

All materials furnished shall meet the requirements of the Material Specifications listed in Section 8 of this specification.

3. EROSION AND SEDIMENT CONTROL MEASURES AND WORKS

The measures and works shall include, but are not limited to, the following:

Staging of Earthwork Activities The excavation and moving of soil materials shall be scheduled to minimize the size of areas disturbed and unprotected from erosion for the shortest reasonable time.

Seeding Seeding to protect disturbed areas shall occur as soon as reasonably possible following completion of that earthwork activity.

Mulching Mulching to provide temporary protection of soil surfaces from erosion.

Diversions Diversions to divert water from work areas and to collect water from work areas for treatment and safe disposition. These works are temporary and shall be removed and the area restored to its near original condition when they are no longer required or when permanent measures are installed.

Stream Crossings Culverts or bridges where equipment must cross streams. These works are temporary and shall be removed and the area restored to its near original condition when they are no longer required or when permanent measures are installed.

Sediment Basins Sediment basins to collect, settle and eliminate sediment from eroding areas from impacting properties and streams below the construction site(s). These works are temporary and shall be removed and the area restored to its original condition when they are no longer required or when permanent measures are installed.

Sediment Filters Straw bale filters or geotextile sediment fences to trap sediment from areas of limited runoff. Sediment filters shall be properly anchored to prevent erosion under or around them. These works are temporary and shall be removed and the area restored to its original condition when they are no longer required or when permanent measures are installed.

Waterways Waterways for the safe disposal of runoff from fields, diversions and other structures or measures. These works are temporary and shall be removed and the area restored to its original condition when they are no longer required or when permanent measures are installed.

Other Additional protection measures as specified in Section 8 of this specification or required by Federal, State, or Local Government.

4. CHEMICAL POLLUTION

The Contractor shall provide water-tight tanks or barrels, or construct a sump sealed with plastic sheets to be used to dispose of chemical pollutants, such as drained lubricating or transmission fluids, grease, soaps, concrete mixer wash water, asphalt, etc., produced as a by-product of the construction activities. At the completion of the construction work, sumps shall be removed and the area restored to its original condition as specified in Section 8 of this specification. Sump removal shall be conducted without causing pollution.

Sanitary facilities such as chemical toilets, or septic tanks shall not be located adjacent to live streams, wells, or springs. They shall be located at a distance sufficient to prevent contamination of any water source. At the completion of construction activities, facilities shall be disposed of without causing pollution as specified in Section 8 of this specification.

5. AIR POLLUTION

The burning of brush and/or slash, and disposal of other materials shall adhere to state and local regulations.

Fire prevention measures shall be taken to prevent the start or spreading of wild fires which may result from project activities. Firebreaks or guards shall be constructed and maintained at locations shown on the drawings.

All public access or haul roads used by the contractor during construction of the project shall be sprinkled or otherwise treated to fully suppress dust. All dust control methods shall insure safe construction operations at all times. If chemical dust suppressants are applied, the material shall be a commercially available product specifically designed for dust suppression and the application shall follow manufacturer's requirements and recommendations. A copy of the product data sheet and manufacturer's recommended application procedures shall be provided to the Engineer five (5) working days prior to the first application.

6. MAINTENANCE, REMOVAL, AND RESTORATION

All pollution control measures and temporary works shall be adequately maintained in a functional condition for the duration of the construction period. All temporary measures shall be removed and the site restored to near original condition.

7. MEASUREMENT AND PAYMENT

Method 1 For items of work for which specific unit prices are established in the contract, each item will be measured to the nearest unit applicable. Payment for each item will be made at the contract unit price for that item. For water or chemical suppressant items used for dust control for which items of work are established in Section 8 of this specification, measurement for payment will not include water or chemical suppressants that are used inappropriately or excessive to need. Such payment will constitute full compensation for the completion of the work.

Method 2 For items of work for which lump sum prices are established in the contract, payment will be made as the work proceeds and supported by invoices presented by the Contractor that reflect actual costs. If the total of all progress payments is less than the lump sum contract price for this item, the balance remaining for this item will be included in the final contract payment. Payment of the lump sum contract price will constitute full compensation for completion of the work.

Method 3 For items of work for which lump sum prices are established in the contract, payment will be prorated and provided in equal amounts on each monthly progress payment estimate. The number of months used for prorating shall be the number estimated to complete the work as outlined in the Contractor's approved construction schedule. The final month's prorate amount will be provided with the final contract payment. Payment as described above will constitute full compensation for completion of the work.

All Methods The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items, and the items to which they are made subsidiary, are identified in Section 8 of this specification.

8. ITEM OF WORK AND CONSTRUCTION DETAILS

The items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 17, Pollution Control

(1) This item shall consist of scheduling of work, installing measures, and performing work as needed to control erosion and minimize the production of sediment and other pollutants to the water and air during construction operations.

These temporary pollution control provisions contained herein shall be coordinated with other temporary and permanent pollution control features specified elsewhere in the contract or by state and local laws to assure effective pollution control.

(2) Stripping or clearing and grubbing shall not be done until the area is needed in the construction operations.

(3) All state and local laws governing pollution shall be followed.

(4) The construction site shall be maintained in a clean and sanitary condition during construction operations.

(5) Trash barrels shall be provided and utilized at the site. Trash shall be regularly collected and disposed of properly.

(6) All waste oil, other chemicals, sewage, and soils contaminated by such pollutants shall be removed from the site and disposed of in approved landfills. This pertains to pollution caused or created by the Contractor.

(7) Earth stockpiles shall be located where runoff and erosion can be controlled in such a manner to minimize the production of sediment and other pollutants to the water during construction operations.

(8) The Contractor shall submit a plan to minimize erosion and sedimentation for technical review by the Engineer and approval by the Contracting Officer before commencing construction operations. Acceptance of the plan will not relieve the Contractor of the responsibility for completing the work as specified.

This plan will contain information on how the Contractor plans to control sediment, which may originate from the embankment, outlet channel, stockpiles, abutments and borrow areas during construction. Details and locations of silt barriers, diversions, sediment traps, and other measures shall be included.

The location and description of the erosion control features may be sketched on the Pollution Control or Borrow Area H-1A sheets.

(9) Straw or grass hay bale filters, if needed, shall be constructed as shown on drawings.

(10) The outlet channel riprap shall be installed immediately after construction of the outlet channel.

(11) The protective dikes shall be installed in a timely manner to prevent erosion.

(12) Payment shall be by Method 2.

b. Installing Measures Other Than Listed in Section "a" Above:

(1) This payment for sediment control does not include the cost of silt fences, sediment removal, mulching, or temporary seeding. These shall be paid for at a unit price as indicated by the appropriate specification. Quantities shown are rough estimates. Pay quantities shall be based on those units actually installed in conformance to the Contractor's approved erosion and sedimentation control plan.

(2) Silt fences shall meet the requirements of Construction Specification 716 and shall be installed as shown on the drawings. Silt fences may be needed at other locations as determined by the Contractor's erosion control plan.

(3) Bare areas that cannot be permanently seeded and mulched within 21 days shall be mulched in accordance with Construction Specification 702 or temporarily seeded in accordance with Construction Specification 703 as designated by the Engineer.

CONSTRUCTION SPECIFICATION

6. SEEDING, SPRIGGING AND MULCHING

1. SCOPE

The work shall consist of preparing the area for treatment, furnishing and placing seed, sprigs, mulch, fertilizer, inoculant, lime and other soil amendments, anchoring mulch and asphalt emulsion in designated areas as specified.

2. MATERIALS

Seed - All seed shall conform to the current rules and regulations of the state where it is being used and shall be from the latest crop available. It shall meet or exceed the standard for purity and germination listed in Section 7.

Seed shall be labeled in accordance with the state laws and the U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act in effect on the date of invitations for bids. Bag tag figures will be evidence of purity and germination. No seed will be accepted with a test date of more than nine (9) months prior to the delivery date to the site.

Seed that has become wet, moldy, or otherwise damaged in transit or storage will not be accepted. The percent of noxious weed seed allowable shall be as defined in the current state laws relating to agricultural seeds. Each type of seed shall be delivered in separate sealed containers and fully tagged unless exception is granted in writing by the Engineer.

Fertilizer - Unless otherwise specified, the fertilizer shall be a commercial grade fertilizer. The fertilizer shall meet the standard for grade and quality specified by state law. Where fertilizer is furnished from bulk storage, the Contractor shall furnish a supplier's certification of analysis and weight. When required by the contract, a representative sample of the fertilizer shall be furnished to the Engineer for chemical analysis.

Inoculants - The inoculant for treating legume seeds shall be a pure culture of nitrogen-fixing bacteria prepared specifically for the species and shall not be used later than the date indicated on the container or as otherwise specified. A mixing medium, as recommended by the manufacturer, shall be used to bond the inoculant to the seed. Two times the amount of the inoculant recommended by the manufacturer shall be used, except four times the amount shall be used when seed is applied by use of a hydraulic seeder. Seed shall be sown within twenty-four (24) hours of treatment and shall not remain in the hydraulic seeder longer than four (4) hours.

Lime and other Soil Amendments - Lime shall consist of Standard Ground Agriculture Limestone, or approved equivalent. Standard Ground Agriculture Limestone is defined as ground limestone meeting current requirements of the State Department of Agriculture. Other soil amendments shall meet quality criteria and application requirements specified in Section 7.

Mulch Tackifiers - Asphalt emulsion tackifiers shall conform to the requirements of ASTM D 977, Specification for Emulsified Asphalt. The emulsified asphalt may be rapid setting, medium setting, or slow setting. Non-asphaltic tackifiers required because of environmental considerations shall be as specified in Section 7.

Straw Mulch Materials - Straw mulch shall consist of wheat, barley, oat or rye straw, hay, grass cut from native grasses or other plants as specified in Section 7. The mulch material shall be air dry, reasonably light in color, and shall not be musty, moldy, caked, or otherwise of low quality. The use of mulch that contains noxious weeds will not be permitted. The Contractor shall provide a method satisfactory to the Engineer for determining weight of mulch furnished.

Other Mulch Materials - Mulching materials, such as wood cellulose fiber mulch, mulch tackifiers, synthetic fiber mulch, netting, and mesh are other mulching materials that may be required for specialized locations and conditions. These materials, when specified, must be accompanied by the manufacturer's recommendations for methods of application.

3. SEEDING MIXTURES, SOD, SPRIGS AND DATES OF PLANTING

The application rate per acre for seed mixtures, sprigs, or sod and date of seeding or planting shall be as shown on the plans or as specified in Section 7.

4. SEEDBED PREPARATION AND TREATMENT

Areas to be treated shall be dressed to a smooth, firm surface. On sites where equipment can operate on slopes safely, the seedbed shall be adequately loosened (4 to 6 inches deep) and smoothed. Depending on soil and moisture conditions, disking or cultipacking or both may be necessary to properly prepare a seedbed. On sites where equipment cannot operate safely, the seedbed shall be prepared by hand methods by scarifying to provide a roughened soil surface so that broadcast seed will remain in place.

If seeding is to be accomplished immediately following construction operations, seedbed preparation may not be required except on compacted, polished, or on freshly cut soil surfaces.

Rocks larger than six (6) inches in diameter, trash, weeds and other debris that will interfere with seeding or maintenance operations shall be removed or disposed of as specified in Section 7.

Seedbed preparation shall be discontinued when soil moisture conditions are not suitable for the preparation of a satisfactory seedbed as determined by the Engineer.

5. SEEDING, SPRIGGING, FERTILIZING, MULCHING, AND STABILIZING

All seeding or sprigging operations shall be performed in such a manner that the seed and/or sprigs are applied in the specified quantities uniformly on the designated areas. The method and rate of seed application shall be as specified in Section 7. Unless otherwise specified, seeding or sprigging shall be accomplished within two (2) days after final grading is completed and approved.

Fertilizer, lime, and other soil amendments shall be applied as specified in Section 7. When specified, the fertilizer and soil amendments shall be thoroughly incorporated into the soil immediately following surface application.

The rate, amount, and kind of mulching or mesh shall be as specified in Section 7. Mulches shall be applied uniformly to the designated areas, and shall be applied to areas seeded not later than two (2) working days after seeding has been performed. Straw mulch material shall be stabilized within twenty-four (24) hours of application by the use

of a mulch crimper or equivalent anchoring tool or by a suitable tackifier. When the mulch crimper or equivalent anchoring tool is used, it shall have straight blades and be the type manufactured expressly for, and capable of firmly punching the mulch into the soil. On sites where the equipment can be safely operated, it shall be operated on the contour. On sites where equipment cannot safely operate to perform the work required, hand methods shall be used.

The tackifier shall be applied uniformly over the mulch material at the specified rate, or by injecting it into the mulch material as it is being applied. The mesh or netting stabilizing materials shall be applied smoothly but loosely on the designated areas, and the edges shall be buried or securely anchored by means of spikes or staples as specified in Section 7.

The Contractor shall maintain the mesh or netting areas until all work under the contract has been completed and accepted. Maintenance shall consist of the repair of areas damaged by water erosion, wind, fire, or other causes. Such areas shall be repaired to re-establish the intended condition and to the design lines and grades required by the contract. The areas shall be re-fertilized, re-seeded, and re-mulched prior to the new application of the mesh or netting.

6. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, each area treated will be measured as specified in Section 7 and the area calculated to the nearest 0.1 acre. Payment for treatment will be made at the contract unit price for the designated treatment, which will constitute full compensation for completion of the work.

When specified as an item of work, mesh or netting will be measured to the nearest square yard of surface area covered and accepted. Payment will be made at the contract unit price and will constitute full compensation for completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the item(s) to which they are made subsidiary are identified in Section 7.

7. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 19, Seeding and Mulching

(1) This item shall consist of all work and materials needed to seed and mulch the designated area.

(2) The area to be seeded and mulched shall include all areas disturbed by construction within the work limits of site H-10D as determined by the Engineer. The limits of the area will be marked on the ground. The bottom of the outlet channel does not require seeding and mulching.

(3) Ground agricultural limestone will be applied at a rate of 1500 lbs./acre of effective neutralizing material (ENM).

(4) Fertilizer furnishing the following minimum amounts of available plant food per acre shall be applied. Fertilizer shall be applied uniformly over the designated seeding area.

Nitrogen (N)	60 pounds
Phosphate (P_2O_5)	90 pounds
Potash (K_2O)	90 pounds

(5) Incorporate lime and fertilizer to a depth of at least 3" into the soil during preparation of the seed bed. All rills and gullies shall be filled and smoothed prior to application of lime and fertilizer.

(6) The seed bed shall be prepared with common farm tools such as disks, harrows, and cultipackers. Areas not accessible to field machinery shall be prepared by hand.

(7) Seed shall be furnished in amounts, which equal or exceed the following rates per acre:

Tall Fescue	24 Pounds (PLS)
Bermudagrass (sprigs)	24 Bushels
Bermudagrass (seed)	6.2 Pounds (PLS)

The Bermudagrass sprigs shall be obtained from a source within 150 miles of the project. Sprigs will be dug and planted at the site within 24 hours. Care will be taken to keep the sprigs fresh, moist and healthy until planted. The seed amounts shown are pure live seed (PLS). Pure live seed percentages equal percent of purity times the percent of germination.

The following seeding and sprigging dates will be used:

Tall Fescue	Bermudagrass (sprigs)	Bermudagrass (seed)
March 1 — May 15 August 16 — October 15 Dec. 16 — Feb. 29 (Dormant)	April 15 — June 1	Nov. 16 — June 15

For dates not shown, all operations will be performed except sowing the seed. Overseeding will be done as seeding dates permit. There will be no tillage during overseeding operations.

From May 16 to August 15, Tall Fescue may be seeded if:

(a) There is adequate soil moisture at the time of planting, determined by the same method as for the minimum moisture content for the earthfill materials.
(b) Seeding rates are increased by 50%.

If construction is completed during a period when Bermudagrass is not recommended, seed to tall fescue. If construction is completed when tall fescue is not recommended, sprig or seed the entire area to Bermudagrass.

(8) Apply seed uniformly at a depth of 1/8 to 1/4 inch with a cultipacker type seeder or broadcast seed uniformly and cover 1/8 to 1/4 inch deep with a cultipacker. The Contractor has the option to apply seed with a hydroseeder on the surface. Seeding operation shall be performed immediately after seed bed preparation, if seeding dates permit. Bermudagrass sprigs shall be planted with a mechanical sprigger. The sprigger will be set to plant 20-inch rows and adjusted to plant 1 to 1½ inches deep.

(9) Mulch shall be small grain straw or grass hay relatively free of weed seed. The mulch shall be chopped and applied uniformly over the designated area at a rate of two tons per acre unless otherwise specified. Anchor mulch with wood cellulose fibertack or a water dispersible mulch tacker following manufacturer's recommendations.

(10) Insofar as practical, all operations shall be performed on the contour.

CONSTRUCTION SPECIFICATION

7. CONSTRUCTION SURVEYS

1. SCOPE

The work shall consist of performing all surveys, measurements and computations required by this specification.

2. EQUIPMENT AND MATERIAL

Equipment for construction surveys shall be of a quality and condition to provide the required accuracy. The equipment shall be maintained in good working order and in proper adjustment at all times. Records of repairs, calibration tests, accuracy checks and adjustments shall be maintained and be available for inspection by the Engineer. Equipment shall be checked, tested, and adjusted as necessary in conformance with manufacturer's recommendations.

Material includes all the necessary field notebooks, stakes, templates, platforms, equipment, spikes, steel pins, tools, and all other items necessary to perform the work specified.

3. QUALITY OF WORK

All work shall follow recognized professional practice and the standards of the industry unless otherwise specified in Section 9 of this specification. The work shall be performed to the accuracy and detail appropriate for the type of job. Notes, sketches, and other data shall be complete, recorded neatly, legible, reproducible and organized in a manner that facilitates ease in review and will allow reproduction of copies for job documentation. Survey equipment that requires little or no manual recording of field data shall have survey information documented as outlined in Section 9 of this specification.

All computations shall be mathematically correct and shall include information to identify the bid item, date, and who performed, checked and approved the computations. Computations shall be legible, complete and clearly document the source of all information used including assumptions and measurements collected.

If a computer program is used to perform the computations, the Contractor shall provide the Engineer with the software identification, vendor's name, version number, and other pertinent data, prior to beginning survey activities. Computer generated computations shall show all input data including values assigned and assumptions made.

The elevations of permanent and temporary benchmarks shall be determined and recorded to the nearest 0.01 foot. Differential leveling and transit traverses shall be of such precision that the error of vertical closure in feet shall not exceed plus or minus 0.1 times the square root of the traverse distance in miles. Linear measurements shall be accurate to within 1.0 foot in 5000 feet, unless otherwise specified in Section 9 of this specification. The angular error of closure for transit traverses shall not exceed 1.0 minute times the square root of the number of angles turned.

The minimum requirements for placing slope stakes shall be at 100 foot stations for tangents, as little as 25-feet for sharp curves, breaks in the original ground surface and at any other intermediate stations necessary to insure accurate location for construction layout and measurement. Slope stakes and cross sections shall be perpendicular to the

centerline. Significant breaks in grade shall be determined for cross sections. Distances shall be measured horizontally and recorded to the nearest 0.1 foot. Side shots for interim construction stakes may be taken with a hand level.

Unless otherwise specified in Section 9 of this specification, measurements for stationing and establishing the location of structures shall be made to the nearest 0.1 foot.

Elevations for concrete work, pipes and mechanical equipment shall be determined and recorded to the nearest 0.01 foot. Elevations for earthwork shall be determined and recorded to the nearest 0.1 foot.

4. PRIMARY CONTROL

The baselines and benchmarks for primary control, necessary to establish lines and grades needed for construction, are shown on the drawings and have been located on the job site.

These baselines and benchmarks shall be used as the origin of all surveys, layouts and measurements to establish construction lines and grades. The Contractor shall take all necessary precautions to prevent the loss or damage of primary control points. Any stakes and/or control points lost or damaged by construction activity will be re-established by the Contractor or at Contractor expense.

5. CONSTRUCTION SURVEYS

Prior to commencement of work requiring contractor performed surveys, the Contractor shall submit in writing for Engineer's review: the name, qualifications and experience of the individual's to be assigned to the survey tasks.

Method 1: Contractor performed surveys shall include: (1) checking and any supplemental or interim staking, (2) performing quantity surveys, measurements and computations for progress payment, (3) other surveys as described in Section 9 of this specification.

Method 2: Contractor performed surveys shall consist of all work necessary for: (1) establishing line and grade for all work, (2) setting slope stakes for all work, (3) checking and any supplemental or interim staking, (4) establishing final grade stakes, (5) performing quantity surveys, measurements and computations for progress payment and (6) other surveys as described in Section 9 of this specification.

Method 3: Contractor performed surveys shall consist of all work necessary for: (1) establishing line and grade for all work, (2) setting slope stakes for all work, (3) checking and any supplemental or interim staking, (4) establishing final grade stakes, (5) performing quantity surveys, measurements and computations for progress payments, (6) performing original (initial) and final surveys for determinations of final quantities, and (7) other surveys as described in Section 9 of this specification.

6. STAKING

Prior to the commencement of work on any item, the construction staking required for the item shall be completed. Construction staking shall be completed as follows, or as otherwise specified in Section 9 of this specification:

a. Clearing and grubbing - The boundary of the area(s) to be cleared and grubbed shall be staked or flagged at a maximum interval of 200 feet, or closer if needed,

to clearly mark the limits of work. When Contractor staking is the basis for determining the area for final payment, all boundary stakes will be reviewed by the Engineer prior to start of this work item.

b. Excavation and fill - Slope stakes shall be placed at the intersection of the specified slopes and ground line. Slope stakes or the reference stakes for slopes shall be marked with the stationing, required cut or fill, slope-ratio and horizontal distance from the centerline or other control line. The minimum requirements for placing slope stakes is outlined in Section 3, Quality of Work.

c. Structures - Centerline and offset reference line stakes for location, alignment and elevation shall be placed for all structures.

7. RECORDS

All survey data shall be recorded in fully identified standard hardbound engineering survey field notebooks with consecutively numbered pages. All field notes and printed data shall include the purpose or description of the work, the date the work was performed, weather data, sketches and the personnel who performed and checked the work. Electronically generated survey data and computations shall be bound; page numbered and cross-referenced in a bound field notebook containing the index for all survey activities. All work shall follow recognized professional practice.

The construction survey records shall be available at all times during the progress of the work for examination and use by the Engineer and when requested, copies shall be made available. The original field notebooks and other records shall be provided to and become the property of the owner prior to final payment and acceptance of all work.

Complete documentation of computations and supporting data for progress payments shall be submitted to the Engineer with each invoice for payment as specified in Section 9 of the specification. When the Contractor is required to conduct initial and final surveys as outlined in Section 5, CONSTRUCTION SURVEYS, notes shall be provided as soon as possible after completion to the Engineer for the purpose of determining final payment quantities.

8. PAYMENT

For items of work for which lump sum prices are established in the contract, payment will be made as the work proceeds, after presentation of correct and accurate invoices by the Contractor showing related costs and evidence of the charges of suppliers, subcontractors, and others for supplies furnished and work performed. Invoices for the total amount of the contract price will not be accepted until all surveys are complete and required documentation has been determined complete. If the total of such payments is less than the lump sum contract price for this item, the unpaid balance will be included in the final contract payment. Payment of the lump sum contract price will constitute full compensation for completion of all work under the bid item.

Payment will not be provided under this item for the purchase price of materials and/or equipment having a residual value.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the item to which they are made subsidiary are identified in Section 9 of this specification.

9. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 3, Construction Surveys

(1) This item shall consist of furnishing personnel, equipment, and materials required to perform the construction surveys specified in Section 5, Method 3.

(2) One copy of field notes in final form shall be submitted to the Contracting Officer's Representative (COR) within one week of survey.

(3) Progress payment computations and the supporting data will be submitted to the COR seven days before an invoice is submitted for the work covered in the progress payment.

(4) The following references and limits are shown on the drawings and will be marked in the field.

a. Centerline of Dam H-10D.

b. Centerline of H-1A and the borrow area limits.

c. East side work limits at Borrow Area H-1A.

d. West side work limits at Dam H-10A.

CONSTRUCTION SPECIFICATION

8. MOBILIZATION AND DEMOBILIZATION

1. SCOPE

The work shall consist of the mobilization and demobilization of the Contractor's forces and equipment necessary for performing the work required under the contract.

This work shall not include mobilization and demobilization for specific items of work for which payment is provided elsewhere in the contract.

Mobilization will not be considered as work in fulfilling the contract requirements for commencement of work.

2. EQUIPMENT AND MATERIALS

Mobilization shall include all activities and associated costs for transportation of Contractor's personnel, equipment, and operating supplies to the site; establishment of offices, buildings, and other necessary general facilities for the Contractor's operations at the site; premiums paid for performance and payment bonds, including coinsurance and reinsurance agreements as applicable; and other items specified in Section 4 of this specification.

Demobilization shall include all activities and costs for transportation of personnel, equipment, and supplies not required or included in the contract from the site; including the disassembly, removal and site clean up, of offices, buildings and other facilities assembled on the site specifically for this contract.

This work includes mobilization and demobilization required by the contract at the time of award. If additional mobilization and demobilization activities and costs are required during the performance of the contract as a result of changed, deleted, or added items of work for which the Contractor is entitled to an adjustment in contract price, compensation for such costs will be included in the price adjustment for the item or items of work changed or added.

3. PAYMENT

Payment will be made as the work proceeds, after presentation of paid invoices and/or documentation of direct costs by the Contractor showing specific mobilization and demobilization costs and supporting evidence of the charges of suppliers, subcontractors, and others. When the total of such payments is less than the lump sum contract price, the balance remaining will be included in the final contract payment. Payment of the lump sum contract price for mobilization and demobilization will constitute full compensation for completion of the work.

Payment will not be made under this item for the purchase costs of materials having a residual value, the purchase costs of materials to be incorporated in the project, or the purchase costs of operating supplies.

4. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 1, Mobilization

(1) This item shall consist of all mobilization and demobilization needed to perform the work.

(2) Ingress-Egress roads and ditch crossings are to be maintained in a condition suitable for normal two-wheel drive light truck traffic.

(3) Item of work subsidiary to this work is:

(a) Ingress-Egress ditch crossings at Borrow Area H-1A.

b. Subsidiary Item, Ingress-Egress Ditch Crossings

(1) This item consists of furnishing all materials, labor and equipment necessary to install two Ingress-Egress ditch crossings for Borrow Area H-1A as shown on the drawings.

(2) Each ditch crossing shall have two; 24-inch diameter pipes, minimum length 30 feet each, as shown on the drawings. The Contractor shall be responsible for determining the type and strength of pipe that will ensure the crossings will perform their function for the duration of the contract.

(3) Ditch crossings will be left in place at the end of construction.

(4) No separate payment will be made for this item. Compensation shall be included in the payment for mobilization.

CONSTRUCTION SPECIFICATION

11. REMOVAL OF WATER

1. SCOPE

The work shall consist of the removal of surface water and ground water as necessary to perform the construction required by the contract in accordance with the specifications. It shall include: (1) constructing, installing, building, and maintaining all necessary temporary water containment facilities, channels, and diversions, (2) furnishing, installing, and operating all necessary pumps, piping, and other facilities and equipment, and (3) removing all such temporary works and equipment after their intended function is no longer required.

2. DIVERTING SURFACE WATER

The Contractor shall install, maintain and operate all cofferdams, channels, flumes, sumps, and all other temporary diversion and protective works needed to divert stream flow and other surface water through or around the construction site. Control of surface water shall be continuous during the period that damage to construction work could occur. Unless otherwise specified and/or approved, the diversion outlet shall be into the same drainage way that the water would have reached before being diverted.

The Contractor shall furnish the Engineer in writing, a proposed plan for diverting surface water before beginning any construction activities for which a diversion is required, unless waived in Section 8 of this specification. Acceptance of this plan, or the waiving of the plan requirement, will not relieve the Contractor of the responsibilities related to this activity during the process of completing the work as specified.

3. DEWATERING THE CONSTRUCTION SITE

Foundations, cutoff trenches, and all other parts of the construction site shall be dewatered and kept free of standing water and muddy conditions as necessary for the proper execution of the work. The Contractor shall furnish, install, operate, and maintain all drains, sumps, pumps, casings, well points, and all other equipment required to properly dewater the site as specified. Dewatering systems that cause a loss of soil fines from the foundation areas will not be permitted.

The Contractor shall furnish the Engineer in writing, a proposed plan for dewatering before commencing with any construction activity that dewatering may be required, unless waived in Section 8 of this specification. Acceptance of this plan, or the waiving of the plan requirement, will not relieve the Contractor of responsibilities for completing the specified work.

4. DEWATERING BORROW AREAS

The Contractor shall maintain all borrow areas free of surface water and otherwise provide for timely and effective removal of surface and subsurface water that accumulates within the borrow area, unless waived in Section 8 of this specification. Borrow material shall be processed as necessary to achieve proper and uniform moisture content at the time of placement.

If pumping to dewater borrow areas is included as a bid item of work in the bid schedule, each pump discharge pipe shall be equipped with a water meter. Meters shall be such that the measured quantity of water is accurate within three (3) percent of the true quantity. The Contractor shall provide necessary support to perform accuracy tests of the water meters when requested by the Engineer.

5. EROSION AND POLLUTION CONTROL

Removal of water from the construction site, including the borrow areas, shall be accomplished in a manner that erosion and the transporting of sediment and other pollutants are minimized. Dewatering activities shall be accomplished in a manner that the water table water quality is not altered. Pollution control activities shall not conflict with the requirements of Construction Specification 5, Pollution Control, if it is a part of this contract.

6. REMOVAL OF TEMPORARY WORKS

When temporary works are no longer needed, the Contractor shall remove and return the area to a similar condition that existed prior to construction. Areas where temporary works were located shall be graded for sightly appearance with no obstruction to natural surface water flows or the proper functioning and access to the works of improvement installed. The Contractor shall exercise extreme care during the removal stages to minimize the loss of soil sediments and debris that was trapped during construction.

Pipes, casings, and any other material used to dewater the site shall be removed from temporary wells. The wells shall be filled to ground level with clean gravel or other suitable material approved by the Engineer unless specified otherwise in Section 8 of this specification. The Contractor shall exercise extreme care to prevent pollution of the ground water by these actions.

7. MEASUREMENT AND PAYMENT

Method 1 Items of work listed in the bid schedule for removal of water, diverting surface water, and dewatering construction sites and borrow areas will be paid for at the contract lump sum prices. Such payment will constitute full compensation for all labor, equipment, tools and all other items necessary and incidental to the completion of the work.

Method 2 Items of work listed in the bid schedule for removal of water, diverting surface water, dewatering construction sites, and dewatering borrow areas will be paid for at the contract lump sum prices. Such payment will constitute full compensation for furnishing, installing, operating, and maintaining the necessary trenches, drains, sumps, pumps, and piping, and for all labor, equipment, tools, and all other items necessary and incidental to the completion of the work, except that additional payment for pumping to dewater borrow areas and the removal of water will be made as described in the following paragraph.

If pumping to dewater borrow areas is a contract bid item, payment will be made at the contract unit price which shall be the price per 1,000 gallons shown in the bid schedule. Such payment will constitute full compensation for pumping only. Compensation for equipment and preparation and for other costs associated with pumping will be included in the lump sum payment for removal of water or the lump

sum payment for dewatering the borrow areas. Payment will be made only for pumping that is necessary to dewater borrow areas that cannot be effectively drained by gravity or that must have the water table lowered to be usable as a suitable borrow source. Pumping for other purposes will not be included for payment under this item.

All Methods The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract, but not listed in the bid schedule, will be included in the payment for the contract line item to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 8 of this specification.

8. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Subsidiary Item, Removal of Water

(1) This item shall consist of all work necessary for diverting surface water and dewatering the work site.

(2) A separate written diverting and dewatering plan is not required, but shall be incorporated into the Erosion and Sediment Control Plan under Construction Specification 5.

(3) No separate payment will be made for this item. Compensation for this item shall be included in the payment for Excavation or Earthfill as appropriate.

CONSTRUCTION SPECIFICATION

21. EXCAVATION

1. SCOPE

The work shall consist of the excavation required by the drawings and specifications and disposal of the excavated materials.

2. CLASSIFICATION

Excavation will be classified as common excavation or rock excavation in accordance with the following definitions or will be designated as unclassified excavation.

Common excavation shall be defined as the excavation of all materials that can be excavated, transported, and unloaded by the use of heavy ripping equipment and wheel tractor-scrapers with pusher tractors or that can be excavated and dumped into place or loaded onto hauling equipment by means of excavators having a rated capacity of one cubic yard or larger and equipped with attachments (such as shovel, bucket, backhoe, dragline or clam shell) appropriate to the material type, character, and nature of the materials.

Rock excavation shall be defined as the excavation of all hard, compacted or cemented materials that requires blasting or the use of ripping and excavating equipment larger than defined for common excavation. The excavation and removal of isolated boulders or rock fragments larger than one (1) cubic yard encountered in materials otherwise conforming to the definition of common excavation shall be classified as rock excavation. The presence of isolated boulders or rock fragments larger than one (1) cubic yard will not in itself be sufficient cause to change the classification of the surrounding material.

For the purpose of these classifications, the following definitions shall apply:

Heavy ripping equipment shall be defined as a rear-mounted, heavy duty, single-tooth, ripping attachment mounted on a track type tractor having a power rating of at least 250 flywheel horsepower unless otherwise specified in Section 11.

Wheel tractor-scraper shall be defined as a self-loading (not elevating) and unloading scraper having a struck bowl capacity of at least twelve (12) cubic yards.

Pusher tractor shall be defined as a track type tractor having a power rating of at least 250 flywheel horsepower equipped with appropriate attachments.

3. UNCLASSIFIED EXCAVATION

Excavation designated as "Unclassified Excavation" shall include all materials encountered regardless of their nature or the manner in which they are removed. When excavation is unclassified, none of the definitions or classifications stated in Section 2, CLASSIFICATION, shall apply.

4. BLASTING

The transportation, handling, storage, and use of dynamite and other explosives shall be directed and supervised by person(s) of proven experience and ability who are authorized and qualified to conduct blasting operations.

Blasting shall be done in such a manner as to prevent damage to the work or unnecessary fracturing of the foundation and shall conform to any special requirements in Section 11 of this specification. When specified in Section 11, the Contractor shall furnish the Engineer in writing, a blasting plan prior to blasting operations.

5. USE OF EXCAVATED MATERIALS

To the extent they are needed, all suitable materials from the specified excavations shall be used in the construction of required permanent earthfill or rockfill. The suitability of materials for specific purposes will be determined by the Engineer. The Contractor shall not waste or otherwise dispose of suitable excavated materials.

6. DISPOSAL OF WASTE MATERIALS

All surplus or unsuitable excavated materials will be designated as waste and shall be disposed of at the locations shown on the drawings.

7. EXCAVATION LIMITS

Excavations shall comply with OSHA Construction Industry Standards (29CFR Part 1926) Subpart P, Excavations, Trenching, and Shoring. All excavations shall be completed and maintained in a safe and stable condition throughout the total construction phase. Structure and trench excavations shall be completed to the specified elevations and to the length and width required to safely install, adjust, and remove any forms, bracing, or supports necessary for the installation of the work. Excavations outside of the lines and limits shown on the drawings or specified herein required to meet safety requirements shall be the responsibility of the Contractor in constructing and maintaining a safe and stable excavation.

8. BORROW EXCAVATION

When the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified earthfills and earth backfills, additional materials shall be obtained from the designated borrow areas. The extent and depth of borrow pits within the limits of the designated borrow areas shall be as specified in Section 11 or as approved by the Engineer.

Borrow pits shall be excavated and finally dressed to blend with the existing topography and sloped to prevent ponding and to provide drainage.

9. OVER-EXCAVATION

Excavation in rock beyond the specified lines and grades shall be corrected by filling the resulting voids with portland cement concrete made of materials and mix proportions approved by the Engineer. Concrete that will be exposed to the atmosphere when construction is completed shall meet the requirements of concrete selected for use under Construction Specification 31, Concrete for Major Structures, or 32, Structure Concrete, as appropriate.

Concrete that will be permanently covered shall contain not less than five (5) bags of cement per cubic yard. The concrete shall be placed and cured as specified by the Engineer.

Excavation in earth beyond the specified lines and grades shall be corrected by filling the resulting voids with approved compacted earthfill, except that, if the earth is to become the subgrade for riprap, rockfill, sand or gravel bedding, or drainfill, the voids may be filled with material conforming to the specifications for the riprap, rockfill, bedding or drainfill. Prior to correcting an over-excavation condition, the Contractor shall review the planned corrective action with the Engineer and obtain approval of the corrective measures.

l0. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of each type and class of excavation within the specified pay limits will be measured and computed to the nearest cubic yard by the method of average cross-sectional end areas or by methods outlined in Section 11 of this specification. Regardless of quantities excavated, the measurement for payment will be made to the specified pay limits, except that excavation outside the specified lines and grades directed by the Engineer to remove unsuitable material will be included. Excavation required because unsuitable conditions result from the Contractor's improper construction operations, as determined by the Engineer, will not be included for measurement and payment.

The pay limits shall be defined as follows:

a. The upper limit shall be the original ground surface as it existed prior to the start of construction operations except that where excavation is performed within areas designated for previous excavation or earthfill the upper limit shall be the modified ground surface resulting from the specified previous excavation or earthfill.

b. The lower and lateral limits shall be the true surface of the completed excavation as directed by the Engineer.

Payment for each type and class of excavation will be made at the contract unit price for that type and class of excavation. Such payment will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to the performance of the work, except that extra payment for backfilling over-excavation will be made in accordance with the following provisions:

Payment for backfilling over-excavation, as specified in Section 9 of this specification, will be made only if the excavation outside specified lines and grades is directed by the Engineer to remove unsuitable material and if the unsuitable condition is not a result of the Contractor's improper construction operations as determined by the Engineer.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 11 of this specification.

11. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 5, Excavation, Common

(1) This item shall consist of common excavation within the limits of the core trench, structure, outlet channel, sewer removal and foundation excavation.

(2) The estimated depth of excavation is to be the elevation shown on the drawings. The Engineer will determine the actual depth after examination of the materials encountered. The actual depth will not vary more than three feet from the estimated depth as shown on the drawings.

(3) Item of work subsidiary to this bid item is:

(a) Removal of Water – Construction Specification 11
(b) Treatment of Rock Surfaces – Construction Specification 63

b. Bid Item 23, Excavation, Sediment Removal

(1) This item shall consist of the common excavation required to remove accumulated sediment from silt fence barriers.

(2) Sediment removal shall be sufficient to provide the original storage volume of this protective measure that was available at installation. Deposits will be disposed of in areas designated by the engineer.

(3) The pay limits shall be defined as follows.

(a) The upper and lateral limits shall be the surface of the sediment deposits before removal begins.
(b) The lower limits shall be the finished surface of the area from where the deposits have been removed.

c. Subsidiary Item, Excavation, Miscellaneous, Common

(1) This item shall consist of all common excavation required within the limits shown on the drawings for the installation of the principal spillway diaphragm, trench drain, access trench, rock gutters and other miscellaneous work.

(2) No separate payment will be made for this item. Compensation for this excavation shall be included in the payment for Drainfill or Rock Riprap as appropriate.

d. Subsidiary Item, Excavation, Auxiliary Spillway, Common

(1) This item shall consist of common excavation from the auxiliary spillway. Excavation shall be to sub-grade 6 inches below the lines and grades shown on the drawings.

(2) The auxiliary spillway material is classified as borrow and shall be utilized as earthfill.

(3) No separate payment will be made for this item. Compensation for this excavation will be included in the payment for Earthfill.

e. Subsidiary Item, Excavation, Foundation Stripping, Common

(1) This item shall consist of removing topsoil and other unsuitable material from the foundation of the dam, auxiliary spillway dikes and Borrow Area H-1A. Materials suitable for topsoil shall be stockpiled in the locations as shown on the drawings, or as marked in the field.

(2) The stripping operation shall be performed in a manner that will produce a minimum amount of soil erosion.

(3) The depth of the excavation required is estimated to be about six to twelve inches. Required stripping deeper than 12 inches will be considered foundation excavation.

(4) No separate payment will be made for this item. Compensation for this excavation will be included in the payment for Earthfill.

CONSTRUCTION SPECIFICATION

23. EARTHFILL

1. SCOPE

The work shall consist of the construction of earth embankments, other earthfills, and earth backfills required by the drawings and specifications.

Earthfill is composed of natural earth materials that can be placed and compacted by construction equipment operated in a conventional manner.

Earth backfill is composed of natural earth materials placed and compacted in confined spaces or adjacent to structures (including pipes) by means of hand tamping, manually directed power tampers or vibrating plates, or equivalent.

2. MATERIALS

All fill materials shall be obtained from required excavations and designated or approved borrow areas. The selection, blending, routing and disposition of materials in the various fills shall be subject to approval by the Engineer.

Fill materials shall contain no frozen soil, sod, brush, roots or other perishable materials. Rock particles larger than the maximum size specified for each type of fill shall be removed prior to compaction of the fill.

The types of materials used in the various fills shall be as listed and described in the specifications and drawings.

3. FOUNDATION PREPARATION

Foundations for earthfill shall be stripped to remove vegetation and other unsuitable materials or shall be excavated as specified.

Except as otherwise specified, earth foundation surfaces shall be graded to remove surface irregularities and shall be scarified parallel to the axis of the fill or otherwise acceptably scored and loosened to a minimum depth of two (2) inches. The moisture content of the loosened material shall be controlled as specified for the earthfill, and the surface materials of the foundation shall be compacted and bonded with the first layer of earthfill as specified for subsequent layers of earthfill.

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of two inches in depth normal to the slope and shall be at such a moisture content that the earthfill can be compacted against them to produce a good bond between the fill and the abutments.

Rock foundation and abutment surfaces shall be cleared of all loose materials by hand or other effective means and shall be free of standing water when fill is placed upon them. Occasional rock outcrops in earth foundations for earthfill, except in dams and other structures designed to restrain the movement of water, shall not require special treatment if they do not interfere with compaction of the foundation and initial layers of the fill or the bond between the foundation and the fill.

Foundation and abutment surfaces shall be not steeper than one (1) horizontal to one (1) vertical unless otherwise specified. Test pits or other cavities shall be filled with compacted earthfill conforming to the specifications for the earthfill to be placed upon the foundation.

4. PLACEMENT

Earthfill shall not be placed until the required excavation and foundation preparation have been completed and the foundation has been inspected and approved by the Engineer. Earthfill shall not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the earthfill matrix.

Earthfill shall be placed in approximately horizontal layers. The thickness of each layer before compaction shall not exceed the maximum thickness specified in Section 10 or shown on the drawings. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified thickness before being compacted.

Hand compacted earth backfill shall be placed in layers whose thickness before compaction does not exceed the maximum thickness specified for layers of earth backfill compacted by manually directed power tampers.

Earth backfill shall be placed in a manner which will prevent damage to the structures and will allow the structures to assume the loads from the earth backfill fill gradually and uniformly. The height of the earth backfill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure.

Earthfill and earth backfill in dams, levees and other structures designed to restrain the movement of water shall be placed so as to meet the following additional requirements:

a. The distribution of materials throughout each zone shall be essentially uniform, and the earthfill shall be free from lenses, pockets, streaks or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material. Zone earthfills shall be constructed concurrently unless otherwise specified.

b. If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than two (2) inches before the next layer is placed.

c. The top surfaces of embankments shall be maintained approximately level during construction, except that a crown or cross-slope of approximately two (2) percent shall be maintained to ensure effective drainage, and except as otherwise specified for drainfill or sectional zones.

d. Dam embankments shall be constructed in continuous layers from abutment to abutment except where openings to facilitate construction or to allow the passage of stream flow during construction are specifically authorized in the contract.

e. Embankments built at different levels as described under (c) or (d) above shall be constructed so that the slope of the bonding surfaces between embankment in place and embankment to be placed is not steeper than three (3) feet

horizontal to one (1) foot vertical. The bonding surface of the embankment in place shall be stripped of all material not meeting the requirements of this specification, and shall be scarified, moistened and re-compacted when the new earthfill is placed against it. This is to insure a good bond with the new earthfill and to obtain the specified moisture content and density at the contact of the in place and new earthfills.

5. CONTROL OF MOISTURE CONTENT

During placement and compaction of earthfill and earth backfill, the moisture content of the materials being placed shall be maintained within the specified range.

The application of water to the earthfill materials shall be accomplished at the borrow areas insofar as practicable. Water may be applied by sprinkling the materials after placement on the earthfill, if necessary. Uniform moisture distribution shall be obtained by disking.

Material that is too wet when deposited on the earthfill shall either be removed or be dried to the specified moisture content prior to compaction.

If the top surface of the preceding layer of compacted earthfill or a foundation or abutment surface in the zone of contact with the earthfill becomes too dry to permit suitable bond it shall either be removed or scarified and moistened by sprinkling to an acceptable moisture content prior to placement of the next layer of earthfill.

6. COMPACTION

Earthfill. Earthfill shall be compacted according to the following requirements for the class of compaction specified:

Class A compaction. Each layer of earthfill shall be compacted as necessary to provide the density of the earthfill matrix not less than the minimum density specified in Section 10 or identified on the drawings. The earthfill matrix is defined as the portion of the earthfill material finer than the maximum particle size used in the compaction test method specified.

Class B compaction. Each layer of earthfill shall be compacted to a mass density not less than the minimum density specified.

Class C compaction. Each layer of earthfill shall be compacted by the specified number of passes of the type and weight of roller or other equipment specified, or by an approved equivalent method. Each pass shall consist of at least one passage of the roller wheel or drum over the entire surface of the layer.

Earth backfill. Earth backfill adjacent to structures shall be compacted to a density equivalent to that of the surrounding in-place earth materials or adjacent required earthfill or earth backfill. Compaction shall be accomplished by means of hand tamping or manually directed power tampers, plate vibrators, walk-behind, miniature, or self-propelled rollers. Unless otherwise specified, heavy equipment including

backhoe mounted powertampers, or vibrating compactors and manually directed vibrating rollers, shall not be operated within two (2) feet of any structure. Towed or self-propelled vibrating rollers shall not be operated within five (5) feet of any structure. Compaction by means of drop weights operating from a crane or hoist will not be permitted.

The passage of heavy equipment will not be allowed:

1. Over cast-in-place conduits prior to 14-days after placement of the concrete.

2. Over cradled or bedded pre-cast conduits prior to seven (7) days after placement of the concrete cradle or bedding.

3. Over any type of conduit until the backfill has been placed above the top surface of the structure to a height equal to one-half the clear span width of the structure or pipe or two (2) feet, whichever is greater, except as may be specified in Section 10.

Compacting of earth backfill adjacent to structures shall not be started until the concrete has attained the strength specified in Section 10 for this purpose. The strength will be determined by compression testing of test cylinders cast by the Contractor's quality control personnel for this purpose and cured at the work site in the manner specified in ASTM C 31 for determining when a structure may be put into service.

When the required strength of the concrete is not specified as described above, compaction of earth backfill adjacent to structures shall not be started until the following time intervals have elapsed after placement of the concrete.

Structure	Time Interval
Vertical or near-vertical walls with earth loading on one side only	14 days
Walls backfilled on both sides simultaneously	7 days
Conduits and spillway risers, cast-in-place (with inside forms in place)	7 days
Conduits and spillway risers, cast-in-place (inside forms removed)	l4 days
Conduits, pre-cast, cradled	2 days
Conduits, pre-cast, bedded	l day
Cantilever outlet bents (backfilled both sides simultaneously)	3 days

7. REWORKING OR REMOVAL AND REPLACEMENT OF DEFECTIVE EARTHFILL

Earthfill placed at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the requirements or removed and replaced by acceptable earthfill. The replacement earthfill and the foundation, abutment and earthfill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control and compaction.

8. TESTING

During the course of the work, the Engineer will perform such quality assurance tests as are required to identify materials; determine compaction characteristics; determine moisture content; and determine density of earthfill in-place. Tests performed by the Engineer will be used to verify that the earthfills conform to contract requirements of the specifications and not as a replacement for the Contractor's quality control program.

Densities of earthfill requiring Class A compaction will be determined in accordance with ASTM D l556, D 2167, D 2922 or D 2937 except that the volume and moist weight of included rock particles larger than those used in the compaction test method specified for the type of fill will be determined and deducted from the volume and moist weight of the total sample prior to computation of density or if using the nuclear gauge, added to the specified density to bring it to the measure of equivalent composition for comparison. The density so computed will be used to determine the percent compaction of the earthfill matrix. Unless otherwise specified, moisture content will be determined by one of the following methods: ASTM D 22l6, D 3017, D 4643, D 4944, or D 4959.

9. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of each type and compaction class of earthfill and earth backfill within the specified zone boundaries and pay limits will be measured and computed to the nearest cubic yard by the method of average cross-sectional end areas or by methods outlined in Section 10 of this specification. Unless otherwise specified in Section 10, no deduction in volume will be made for embedded items such as, but not limited to: conduits, inlet structures, outlet structures, embankment drains, sand diaphragm and outlet, and their appurtenances.

The pay limits shall be as defined below, with the further provision that earthfill required to fill voids resulting from over-excavation of the foundation, outside the specified lines and grades, will be included in the measurement for payment only where such over-excavation is directed by the Engineer to remove unsuitable material and where the unsuitable condition is not a result of the Contractor's improper construction operations as determined by the Engineer. Earthfill beyond the specified lines and grades to backfill excavation required for compliance with OSHA requirements will be considered subsidiary to the earthfill bid item(s).

The pay limits shall be the specified pay limits for excavation and the specified neat lines of the earthfill surface.

Payment for each type and compaction class of earthfill and earth backfill will be made at the contract unit price for that type and compaction class of earthfill. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work.

The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 10 of this specification.

10. ITEM OF WORK AND CONSTRUCTION DETAILS

The impact basin, principal spillway pipe and outlet channel shall be completed prior to making closure of the embankment. Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 6, Earthfill, Class A

(1) This item shall consist of the construction of the earthfill required for the embankment, auxiliary spillway dikes, and the earthfill required for backfilling the core trench, structure excavation, sewer removal excavation and trench drain access trench as shown on the drawings.

(2) Placement and compaction shall be as shown on the drawings.

(3) The foundation in the embankment and auxiliary spillway dike areas shall be compacted to the same density as the adjacent Class A earthfill.

(4) When water is added, a heavy-duty disk type plow shall be required for scarifying, mixing and processing Class A earthfill materials.

(5) Topsoil shall be placed on all exposed earthfill as shown in the note on the drawings and in accordance with Construction Specification 26.

(6) Items of work subsidiary to this bid item are:

(a) Removal of Water – Construction Specification 11.

(b) Excavation, Foundation Stripping, Common – Construction Specification 21.

(c) Excavation, Auxiliary Spillway, Common – Construction Specification 21.

(d) Earthfill, Protective Dikes – Construction Specification 23.

b. Bid Item 7, Off-Site Borrow, Excavation & Hauling

(1) This item shall consist of the common excavation and hauling of earthfill and topsoil from the H-1A Borrow Area to site H-10D. The round trip distance is approximately 4.5 miles. The Contractor shall route all haul vehicles by the "Required Haul Route" as shown on the drawings.

(2) Measurement for determination of the quantities excavated and hauled shall be as follows:

(a) Earthfill – Quantities hauled to site H-10D shall be computed by the average end area method. The ground surface as it exists after stripping shall define the upper limits and the lower and lateral limits shall be the true surface of the completed excavation. Average end areas shall be measured by cross sections perpendicular to the centerline of Borrow Area H-1A and located at intervals that are representative of the borrow area. Representative cross sections shall not be spaced more than 50 feet apart.

(b) Topsoil – After stripping, the topsoil stockpile shall be bladed and dressed to a reasonably consistent cross section. Quantities hauled to site H-10D shall be computed by the average end area method. Average end areas shall be measured by cross sections perpendicular to the centerline of Borrow Area H-1A and located at intervals representative of the stockpile. Representative cross sections shall not be spaced more than 50 feet apart.

(3) Payment for the quantities of earthfill and topsoil hauled will be made at the contract unit price per cubic yard as determined by measurement according to Section 10.b.(2) of this specification.

c. Subsidiary Item, Earthfill, Protective Dikes

(1) This item shall consist of the construction of the protective dikes to the dimensions and at the approximate location shown on the drawings.

(2) Compaction shall be Class C and shall consist of complete coverage over the surface of the completed dike with the hauling, spreading, or shaping equipment. Moisture content of the fill shall be sufficient for shaping and compacting.

(3) Protective dikes shall be constructed in a manner that will provide the greatest protection from soil erosion.

(4) No separate payment will be made for this item. Compensation for this item will be included in the payment for Earthfill.

CONSTRUCTION SPECIFICATION

24. DRAINFILL

1. SCOPE

The work shall consist of furnishing, placing and compacting drainfill required in the construction of structure drainage systems.

2. MATERIALS

Drainfill materials shall conform to the requirements of Material Specification 521. A minimum of thirty (30) days prior to delivery of materials to the site, the Contractor shall inform the Engineer in writing of the source(s) from which drainfill material will be obtained. The Contractor shall provide the Engineer free access to the source(s) for the purpose of obtaining samples for testing.

3. BASE PREPARATION

Foundation surfaces and trenches shall be clean and free of organic matter, loose soil, foreign substance, and standing water when the drainfill is placed. Earth surfaces upon or against which drainfill will be placed shall not be scarified.

4. PLACEMENT

Drainfill shall not be placed until the subgrade has been inspected and approved by the Engineer. Drainfill shall not be placed over or around pipe or drain tile until the installation of the pipe or tile has been inspected and approved.

Drainfill shall be placed uniformly in layers not to exceed twelve (12) inches thick prior to compaction. When compaction is accomplished by manually controlled equipment, the layers shall not exceed eight (8) inches thick. The material shall be placed in a manner to avoid segregation of particle sizes and to insure the continuity and integrity of all zones. No foreign materials shall be allowed to become intermixed with or otherwise contaminate the drainfill.

Traffic shall not be permitted to cross over drains at random. Equipment cross-overs shall be maintained, and the number and location of such cross-overs shall be established and approved prior to the beginning of drainfill placement. Each cross-over shall be cleaned of all contaminating materials and shall be inspected and approved by the Engineer prior to the placement of additional drainfill material.

Any damage to the foundation surface or the trench sides or bottom occurring during placement of drainfill shall be repaired before drainfill placement is continued.

The upper surface of drainfill constructed concurrently with adjacent zones of earthfill shall be maintained at a minimum elevation of one (1) foot above the upper surface of adjacent earthfill.

Drainfill over and/or around pipe or drain tile shall be placed in a manner to avoid any displacement in line or grade of the pipe or tile.

Drainfill shall not be placed adjacent to structures until the concrete has attained the strength specified in Section 9 of this specification. The strength shall be determined by compression testing of concrete test cylinders cast and field cured at the project site in accordance with ASTM Method C 31 for determining when a structure may be placed into service.

When the required strength of the concrete is not specified as described above, placement of drainfill adjacent to concrete structures shall not be commenced until the following item intervals have elapsed following placement of the concrete:

Structure Type	Time Interval
Vertical or near-vertical wall with earth loading on one side only (Retaining walls and counterforts)	14 days
Walls backfilled on both side simultaneously	7 days
Conduits and galleries, cast-in-place (with inside forms in place)	7 days
(inside forms removed)	14 days
Conduits, precast, cradled	2 days
Conduits, precast, bedded	1 day
Cantilever outlet bents backfilled on both sides simultaneously	3 days

5. CONTROL OF MOISTURE

The moisture content of drainfill materials shall be controlled as specified in Section 9 of this specification. When the addition of water is required, it shall be applied in a manner to avoid excessive wetting to adjacent earthfill. Except as specified in Section 9 of this specification, control of moisture content will not be required.

6. COMPACTION

Drainfill shall be compacted according to the following requirements for the class of compaction specified:

Class A compaction. For drainfill materials with more than 70% passing the 3/4 inch sieve, each layer of drainfill shall be compacted to a minimum dry density of not less than the density specified in Section 9 of this specification as determined by ASTM D698.

For drainfill materials with 70% or less passing the 3/4 inch sieve, each layer of drainfill shall be compacted to a relative density of not less than 70% as determined by ASTM D4254.

Class I compaction. Each layer of drainfill shall be compacted by a minimum of two (2) passes, over the entire surface, with a steel-drum vibrating roller weighing a minimum of five (5) tons and exerting a vertical vibrating force of not less than 20,000 pounds at a minimum frequency of 1200 times per minute, or by an approved equivalent method.

Class II compaction. Each layer of drainfill shall be compacted by one of the following methods or by an approved equivalent method (A pass is defined as at least one complete coverage of the roller wheel, tire or drum over the entire surface for each layer):

a. A minimum of two (2) passes over the entire surface with a pneumatic-tired roller exerting a minimum pressure of 75 pounds per square inch (psi).

b. A minimum of four (4) passes over the entire surface with the track of a crawler-type tractor weighing a minimum of 20 tons.

c. Controlled movement of the hauling equipment so that the entire surface is traversed by not less than one tread track of the loaded hauling equipment.

Class III compaction. No compaction will be required beyond that resulting from the placing and spreading operations.

When compaction other than Class III compaction is specified, materials placed in trenches or other locations inaccessible to heavy equipment shall be compacted by means of manually controlled pneumatic or vibrating tampers as specified in Section 9 of this specification.

Heavy equipment shall not be operated with 2 feet of any structure. Vibrating rollers shall not be operated within 5 feet of any structure. Compaction by means of drop weights operating from cranes, hoists, or similar equipment will not be permitted.

7. TESTING

The Contractor shall conduct such tests as necessary to verify that the drainfill materials and the in place drainfill meets the specification requirements.

The Engineer shall be granted access to perform such tests as are required to verify that the drainfill materials and the drainfill in place meets the requirements of the specifications. These tests are not intended to provide the Contractor with information needed to assure that the materials and workmanship meet the specification requirements. These verification tests will not relieve the Contractor of the responsibility of performing required tests for that purpose.

8. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of drainfill within the neat lines shown on the drawings will be measured and computed to the nearest cubic yard. Where the Engineer directs placement of drainfill outside the neat lines to replace unsuitable foundation material, the volume of such

drainfill will be included. The volume included will only be to the extent that the unsuitable condition is not a result of the Contractor's improper construction operation in the determination of the Engineer.

Payment for drainfill will be made at the contract unit price for each type of drainfill, complete in place. Except as otherwise specified in Section 9 of this specification, such payment will constitute full compensation for all labor, equipment, materials, and all other items necessary and incidental to the performance of the work.

Compensation for any item of work described in the contract but not included in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 9 of this specification.

9. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 8, Drainfill

(1) This item shall consist of furnishing and installing the drainfill as required in the construction of the foundation drainage system and principal spillway diaphragm. Gradation of the material shall be as shown on the drawings.

(2) Materials shall conform to Material Specification 521. Crushed limestone shall not be used.

(3) Compaction and Placement requirements are:

(a) Fine drainfill in the principal spillway diaphragm shall be placed in layers not more than 8 inches deep and compacted as follows:

Water shall be applied to each layer at a rate that free draining water is available in the sand during compaction. Immediately after applying water each layer shall be compacted by one pass of a manually controlled vibrating tamper or equivalent. The vibrating tamper shall deliver a minimum manufacturer's rated frequency of 2,500 pounds of centrifugal force and 4,000 vibrations per minute frequency.

(b) The remaining fine drainfill shall be placed in approximate 12-inch thick layers. Each layer shall be saturated with water as it is being placed or immediately after placement.

(c) Compaction of the medium drainfill shall be Class III.

(4) Item of work subsidiary to this bid item is:

(a) Excavation, Miscellaneous – Construction Specification 21.

CONSTRUCTION SPECIFICATION

26. TOPSOILING

1. SCOPE

The work shall consist of furnishing and spreading topsoil to specified depths at locations shown on the drawings.

2. QUALITY OF TOPSOIL

Topsoil shall consist of friable surface soil reasonably free of grass, roots, weeds, sticks, rocks or other unsuitable materials. Additional quality requirements, if any, are contained in Section 7 of this specification.

3. FURNISHING

Topsoil shall be salvaged from designated earth surfaces that will be disturbed by construction activities. After designated sites have been cleared and grubbed, the topsoil shall be removed from the designated areas and shall be stockpiled at locations shown on the drawings or acceptable to the Engineer. Unsuitable materials encountered during removal of topsoil shall be disposed of at locations shown on the drawings or approved by the Engineer, or otherwise hauled and disposed of at locations removed from the construction site. The Contractor is responsible for complying with all local rules and regulations and the payment of any and all fees that may result from the disposal at locations outside the construction work limits.

4. STOCKPILING

Stockpiles of topsoil shall not conflict with the requirements of Construction Specification 5, Pollution Control, when made a part of this contract.

5. SPREADING

Spreading shall not be performed when the ground or topsoil is frozen, excessively wet or otherwise in a condition detrimental to uniform spreading operations. Surfaces designated to receive a topsoil application shall be lightly scarified just prior to the spreading operation. Where compacted earthfills are designated to be topsoiled, the topsoil shall be placed concurrently with the earthfill and shall be bonded to the compacted fill with the compacting equipment.

Following the spreading operation, the topsoil surface shall be left reasonably smooth and without ruts or surface irregularities that could contribute to concentrated water flow down slope.

6. MEASUREMENT AND PAYMENT

The total surface(s) covered by topsoil, except the surface area(s) of embankments, levees, dikes and other earthfills will not be included for payment, will be measured and the area(s) computed to the nearest square yard.

Payment for topsoil spread on the surfaces of embankments, levees, dikes and other earthfills will be included in the measurement and payment for that item of earthfill where topsoil application occurred.

The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 6 of this specification.

Payment will constitute full compensation for all labor, equipment, materials and all other items necessary and incidental to the completion of the work, including excavating, stockpiling, hauling, and spreading, including the wasting of unsuitable excavated material.

7. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 9, Salvaging and Spreading Topsoil

(1) This item shall consist of salvaging and spreading topsoil on the excavated areas of the auxiliary spillway and the side slopes of the outlet channel to a minimum depth of 6 inches.

(2) Topsoil placed on excavated areas will be measured on the horizontal plane.

(3) Topsoil placed on the dam and auxiliary spillway dikes is paid for as Earthfill.

CONSTRUCTION SPECIFICATION

31. CONCRETE FOR MAJOR STRUCTURES

1. SCOPE

The work shall consist of furnishing, forming, placing, finishing and curing portland cement concrete as required to build the structures designated in Section 25 of this specification.

2. MATERIALS

Aggregates shall conform to the requirements of Section 25 and Material Specification 522 unless otherwise specified.

Portland cement shall conform to the requirements of Material Specification 531 for the specified type. One brand only of any type of cement shall be used in any single structure as defined in Section 25.

Fly ash shall conform to the requirements of Material Specification 532.

Blast-furnace slag used as a partial substitution of portland cement in concrete shall conform to the requirements of Material Specification 532.

Air-entraining admixtures shall conform to the requirements of Material Specification 533. If air-entraining cement is used, any additional air-entraining admixture shall be of the same type as that in the cement.

Plasticizing admixtures shall conform to the requirements of Material Specification 533.

Water-reducing and/or retarding admixtures shall conform to the requirements of Material Specification 533.

Accelerating and water-reducing and accelerating admixtures, if specified in Section 25, shall conform to the requirements of Material Specification 533.

Curing compound shall conform to the requirements of Material Specification 534.

Preformed expansion joint filler shall conform to the requirements of Material Specification 535.

Sealing compound for joints shall conform to the requirements of Material Specification 536.

Waterstops shall conform to the requirements of Material Specifications 537 and 538 for the specified kinds.

Dowels shall be a plain round steel bar conforming to the requirements of Material Specification 539.

Metal plates shall conform to the requirements of Material Specification 581 for structural quality or commercial or merchant quality steel. Structural quality shall be used only if specifically designated in the drawings or specifications.

Water used in mixing and curing concrete shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter or other deleterious substances.

3. CONCRETE MIX DESIGN

Method 1

Responsibilities. The Contractor shall be responsible for the design and proportioning of the concrete. Job mixes shall be prepared to meet the quality, consistency and strength of concrete specified.

Submittals. At least 15 calendar days prior to the placement of any concrete the Contractor shall provide the Engineer with full documentation to support each job mix and any admixtures to be used in the work. The Contractor shall furnish test results to the Engineer for each admixture showing that it meets the requirements of Material Specification 533. Job mixes will be reviewed and accepted or rejected by the Engineer within 8 calendar days following the date of submittal. After a job mix has been accepted, neither the source, character, or gradation of the aggregates nor the type or brand of cement or admixtures shall be changed without prior notice to the Engineer. Revisions or changes in a job mix, which are determined to be significant by the Engineer, shall follow the same submittal and acceptance process as for initial job mix.

Design Criteria.

The class of concrete shall be as specified in Section 25 and in accordance with the following specified compressive strength.

Class of Concrete	Specified Compressive Strength (f'_c) at 28 days, (psi)
5000	5000
4000	4000
3000	3000
2500	2500

Maximum water-cement ratio shall be 0.50, unless otherwise specified.

Unless otherwise specified the air content (by volume) of the concrete at the time of placement shall be:

Maximum Size Aggregate	Air Content (%)
3/8 inch to l inch	5 to 7
Over l inch	4 to 6

The consistency of all concrete shall allow it to be placed without segregation or excessive laitance. Unless otherwise specified, the slump shall be:

Type of Structural Section	Slump (inches)
Massive sections, pavements, footings	2 ± 1
Heavy beams, thick slabs, thick walls (over 12 in)	3 ± 1
Columns, light beams, thin slabs, thin walls (12 in or less)	4 ± 1

Superplasticized concrete shall be a concrete mix containing either a water-reducing, high range admixture (ASTM C 494, Type F or G) at a dosage rate that reduces the quantity of water required to produce a concrete mix within the above slump range by 12% or more, or a plasticizing admixture (ASTM C 1017) at a dosage rate required to produce an increase in the slump of at least 2 inches more than that specified above.

Water-reducing admixtures (ASTM C 494) shall not be used to increase the slump of the concrete mix to a slump greater than the slump requirements specified above.

A plasticizing admixture (ASTM C 1017) may be added to an approved job mix without resubmittal and reapproval of the job mix if the following requirements are met:

a. The plasticizing admixture shall be introduced into the concrete mix as specified by the manufacturer and be compatible with other admixtures in the job mix.

b. The water content shall be equal to or less than that required in the job mix without the admixture.

c. The cement content shall be the same as that required in the job mix without the admixture.

d. The air content shall be within the specified range.

e. The slump shall not exceed 7-1/2 inches unless the Contractor can demonstrate prior to placement that the job mix can be placed without segregation or excessive laitance at a slump between 7-1/2 inches and 9 inches. The concrete shall retain the increased slump for not less than 30 minutes.

f. If a plasticizing admixture is added at the job site, the slump of the concrete prior to the addition of the admixture shall not exceed the slump specified above for concrete that does not contain a plasticizing admixture.

Calcium chloride or other corrosive accelerators shall not be used, unless otherwise specified.

Fly ash may be used as a partial substitution for portland cement in an amount not greater than 25 percent (by weight) of cement in the concrete mix, unless otherwise specified.

Ground granulated blast-furnace slag may be used as a partial substitution for portland cement in amounts between 25 to 70 percent (by weight) of cement in the concrete mix, unless otherwise specified.

Job Mix Criteria.

Proportioning of concrete for job mixes shall be based on either the standard deviation computed from compressive strength tests of previous batch records, or established by laboratory trial mixes. A compressive strength test is the average of the compressive strengths of two standard cured cylinders prepared and tested in accordance with Section 4, unless otherwise specified.

a. For a job mix based upon the standard deviation computed from compressive strength tests of previous batch records, the previous batches shall represent similar materials and conditions to those expected for the job mix and have a strength within 1000 psi of the specified compressive strength (**f 'c**) at 28 days for the class of concrete specified. The Contractor shall provide to the Engineer copies of the facility's previous batching records that shows the compressive strength results and the batch mix design used.

b. For a job mix based upon a laboratory trial mix, the trial mix shall contain the actual materials to be used in the final job mix, have a slump within 0.75 inches of the maximum allowable slump, and have an air content within 0.5% of the maximum allowable air content. The Contractor shall provide the Engineer with copies of the actual compressive strength test records for the trial mix from the testing facility performing the test.

c. The trial job mix or previous batch records shall include the water-reducing admixture when a water-reducing admixture is used in a concrete mix specifically to improve the physical properties of the hardened concrete or change portions of the mix components.

d. In meeting strength requirements, the selected job mix proportions must produce an average strength, $\mathbf{f_{cr}}$, exceeding the specified compressive strength, **f 'c**, by the amount specified below.

n	$\mathbf{s_{30}}$	$\mathbf{f_{cr}}$
>30	1.00 **s**	The larger of these
25	1.03 **s**	two equations:
20	1.08 **s**	**f 'c** + 1.34 $\mathbf{s_{30}}$
15	1.16 **s**	**f 'c** + 2.33 $\mathbf{s_{30}}$ - 500
<15		**f 'c** + 1000 for **f 'c** < 3000 **f 'c** + 1200 for **f 'c** ≤ 5000 **f 'c** + 1400 for **f 'c** > 5000

where **n** = number of consecutive compressive strength tests,
$\mathbf{s_{30}}$ = standard deviation adjusted to 30 tests, psi,
$\mathbf{f_{cr}}$ = required average compressive strength, psi,
f 'c = specified compressive strength of concrete, psi,
s = standard deviation, psi, computed as,
s = $\{[\text{sum}\mathbf{(Xi-Xa)^2}]/\mathbf{[n-1]}\}^{\mathbf{1/2}}$
where **Xi** = individual strength test result, psi, and
Xa = average of n strength test results, psi.

Method 2

Responsibilities. The Engineer will be responsible for the design and proportioning of the job mix. The initial job mix will be as specified in Section 25. The Engineer may adjust the initial job mix proportions to establish the designated job mix. The Engineer will provide the Contractor with a copy of each job mix as soon as the materials and proportions have been determined. After the job mix has been designated, neither the source, character or gradation of the aggregates nor the type or brand of cement or admixtures shall be changed without prior approval of the Engineer. During the course of the work, the Engineer may adjust the job mix proportions and batch weights whenever necessary to meet special job conditions.

The Contractor, for each class of concrete, shall be responsible for:

a. Taking the following actions and furnish the Engineer with the below information at least 35 calendar days prior to any placement of concrete, unless otherwise designated:

   (1) Select the source of aggregates and sample and test the gradations of aggregates available;

   (2) Select the brand and type of cement;

   (3) Select the brand of admixtures and obtain manufacturer's test data and recommendation of use;

   (4) Identify the concrete production facility, the type of mixer, and the mixing methods that will be used; and

   (5) Provide from the concrete production facility consecutive compressive strength test records and batching records for concrete mixes that have materials, proportions, and compressive strengths within 1000 psi of the proposed design mix.

b. Batching at least 3 cubic yards of the initial job mix, in the presence of the Engineer, for testing and evaluation not less than 30 calendar days prior to any placement of concrete.

4. INSPECTING AND TESTING

During the course of the work, the Engineer will perform quality assurance testing as required to assure the concrete meets the contract requirements. The Engineer shall have free entry to the plant and equipment furnishing concrete under the contract. Proper facilities shall be provided for the Engineer to inspect materials, equipment and processes, and to obtain samples of the concrete. All tests and inspections will be conducted so as not to interfere unnecessarily with the manufacture, delivery, and placement of the concrete.

Any portion of a batch may be tested by the Engineer for any of the purposes below. Samples taken for testing shall be representative of that portion of the batch.

a. Determining uniformity of the batch.

b. Checking compliance with requirements for slump and air content when the batch is discharged over an extended period of time.

c. Checking compliance of the concrete with the specifications when the whole amount being placed in a small structure, or a distinct portion of a larger structure, is less than full batch.

If concrete is conveyed to the placement location by pumping or conveyor belts, the samples shall be collected at the discharge end.

When a plasticizing admixture is added to the concrete mix at the job site, slump tests will be made both prior to the addition of the admixture to the concrete mix and after the admixture has been incorporated into the concrete mix.

The tests on concrete will be performed by the following methods indicated, unless otherwise specified:

Type of Test	Test Method (ASTM Designation)
Sampling	C 172
Slump Test	C 143
Air Content	C 231 or C 173
Compression Test Specimens	C 31 or C 42
Compressive Strength Testing	C 39
Unit Weight	C 138
Temperature	C 1064

A strength test for concrete shall be the average of two standard cured concrete cylinders prepared in accordance with ASTM C 31 from the same sample of concrete and tested in accordance with ASTM C 39 at 28 days, unless otherwise specified. If one cylinder shows manifest evidence of improper sampling, molding, curing or testing, it shall be discarded and the strength of the remaining cylinder shall then be considered the compressive strength of the concrete. Should both cylinders show such defects, the entire test shall be discarded.

If both cylinders are discarded or inplace concrete which was not sampled is in question, the inplace concrete may be sampled by coring in accordance with ASTM C 42. For core tests, the below requirements shall be followed:

a. At least three representative cores shall be taken from each area of concrete in question. If one or more of the cores shows signs of being damaged prior to testing, it shall be replaced by a new one.

b. Test cores shall be prepared for testing in accordance with moisture conditioning in ASTM C 42, unless the Engineer determines that the concrete in the structure will be dry under service conditions. If the concrete is determined to be dry under service conditions, the cores shall be air dried (temperature 60^{o} to 80^{o}F and relative humidity less than 60%) for 7 days before testing and shall be tested dry.

5. HANDLING AND MEASUREMENT OF MATERIALS

Aggregates shall be stored or stockpiled in such a manner that separation of coarse and fine particles of each size will be avoided and that various sizes will not become intermixed before proportioning. Methods of handling and transporting aggregates shall be such as to avoid contamination, excessive breakage, segregation, degradation, or intermingling of various sizes.

Unless otherwise specified, scales shall be beam type or springless dial type. They shall be accurate when static load tested to ±0.4% of the total capacity of the scales. All exposed fulcrums, clevises and similar working parts of scales shall be kept clean.

Measuring tanks for mixing water shall be of adequate capacity to furnish the maximum amount of mixing water required per batch. Tanks shall be equipped with outside taps and valves to verify their calibration unless other means are provided for readily and accurately determining the amount of water in the tank.

The quantities of each component of the concrete mix shall be measured by the following methods and to the accuracy indicated below:

Cement, Fly Ash, Slag. Cement, except as otherwise specifically permitted, shall be measured by weight or in bags which have the weight plainly marked on the bag. When cement, fly ash, and slag are supplied in bulk and are measured by weight, they shall be weighed on a scale separate from that used for other materials, and in a hopper entirely free and independent of the hopper used for weighing the aggregate. When fly ash or slag is used in the job mix, the cement and the fly ash or slag may be weighed separately, or cumulatively by weighing the cement first and then adding the fly ash or slag to arrive at the composite weight. The weight of the cement and the combined weight of the cement and fly ash or slag shall be ±1% of the required weight of the cementitious materials. When cement is measured in bags, no fraction of a bag shall be used unless weighed.

Aggregates shall be measured by weight, unless otherwise specifically permitted. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be the required saturated, surface-dry weight corrected by the weight of surface moisture it contains. The weight of each of the specified aggregates shall be ±2% of the required weight.

Mixing water shall consist of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates, and water introduced in the form of admixtures. The added water shall be measured by weight or volume to an accuracy of l% of the required total mixing water. Added ice shall be measured by weight. Wash water shall not be used as a portion of the mixing water for succeeding batches.

Admixtures. Dry admixtures shall be measured by weight. Paste or liquid admixtures shall be measured by weight or volume. The admixtures shall be ±3% of the required weight or volume for each specific admixture.

6. MIXERS AND MIXING

Mixers are either stationary parts of a central mixing plant or portable equipment; such as, revolving drum truck mixers and volumetric batching/continuous mixing truck mixers. Mixers shall be capable of thoroughly mixing the concrete ingredients into a uniform mass within the specified mixing time and of discharging the mix without segregation. Each mixer or agitator shall bear a manufacturer's rating plate indicating the gross volume of the drum, the capacity of the drum or container in terms of the volume of mixed concrete, and the minimum and maximum mixing speeds of rotation of the drum, blades, or paddles. When the truck mixer is used for truck mixed concrete as described in Section 6,a,(2) or for shrink mixed concrete as described in Section 6,a,(3), the capacity of the drum or container in terms of the volume of mixed concrete shall not exceed 63% of the gross volume of the drum. When the truck mixer is used to transport central-mixed concrete as described in Section 6,a,(1), the capacity of the drum or container in terms of the volume of mixed concrete shall not exceed 80% of the gross volume of the drum. The mixer shall be operated in accordance with these recommendations.

Concrete shall be uniform and thoroughly mixed when delivered to the forms in a freshly mixed and unhardened state. Variations in slump of more than one (1) inch within a batch will be considered evidence of inadequate mixing and shall be corrected by changing batching procedures, increasing mixing time, changing mixers or other means. Mixing time shall be within the limits specified below unless the Contractor demonstrates by mixer performance tests that adequate uniformity is obtained by different times of mixing.

No mixing water in excess of the amount called for by the job mix shall be added to the concrete during mixing or hauling or after arrival at the delivery point. Water to compensate for up to a one (1) inch loss in slump may be added, not to exceed the design maximum water cement ratio. Withholding some of the mixing water until the concrete arrives on the job, then adding the remaining water and turning the mixer 30 revolutions at mixing speed will be allowed to overcome transporting conditions. When loss of slump or workability cannot be offset by these measures, complete mixing shall be performed by on-site batching and mixing, or by using a combination of centrally batching and transporting materials to the site and adding remainder of materials onsite.

Concrete may be furnished by (a) ready-mix methods, (b) by volumetric batching and continuous mixing at the site, or (c) by batch mixing at the site.

a. Ready-Mixed Concrete. Ready-mixed concrete shall be mixed, transported, and placed in a freshly mixed and unhardened state.

The Contractor shall furnish the Engineer a batch ticket showing amount of concrete in cubic yards; the time of loading; the time the load was discharged; the revolution counter reading at the time of loading and discharge; and the type and actual quantity of each material, including all admixtures, used in each batch of concrete.

Truck mixers and truck agitators shall be equipped with revolution counters by which the number of revolutions of the drum or blades may be readily verified.

Ready-mixed concrete shall be mixed and delivered by one of the following methods:

(1) **Central-Mixed Concrete.** Central-mixed concrete is mixed completely in a stationary mixer and transported to the point of delivery either in a truck agitator, a truck mixer operating at agitating speed, or nonagitating equipment.

When a truck agitator or a truck mixer is used as an agitator and transports concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed. When concrete is transported in a truck mixer or truck agitator, the volume of the mixed concrete shall not exceed 80% of the gross volume of the drum. The total number of revolutions of the truck mixer or truck agitator shall not exceed 200 before discharge of the concrete, unless otherwise specified.

The use of nonagitating equipment to transport concrete to the site of the work will be permitted only if the consistency and uniformity of the concrete as discharged at the point of delivery meet the requirements of this specification. Bodies of nonagitating hauling equipment shall be so constructed that leakage of the concrete mix, or any part thereof will not occur. Concrete hauled in open-top vehicles shall be protected from rain, and from more than 20 minutes exposure to the sun and wind when the air temperature is above 75^{o}F.

(2) **Truck-Mixed Concrete.** Truck-mixed concrete is completely mixed in a truck mixer. The total volume of all ingredients to be mixed in a revolving drum truck mixer shall not exceed 63% of the gross volume of the drum. The concrete ingredients shall be mixed between 70 and 100 revolutions of the drum or blades at the speed designated by the manufacturer as mixing speed. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed. The total number of revolutions shall not exceed 300 before discharge of the concrete, unless otherwise specified.

(3) **Shrink-Mixed Concrete.** Shrink-mixed concrete is partially mixed at a central plant and the mixing is completed in a truck mixer, the mixing time in the central plant mixer shall be the minimum required to intermingle the ingredients. The volume of the mixed concrete in a truck mixer shall not exceed 63% of the gross volume of the truck drum. The mixing shall be completed in a truck mixer. The number of revolutions of the truck mixer drum or blades shall be between 50 and 100 revolutions at the speed designated by the manufacturer as mixing speed. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed. The total number of revolutions shall not exceed 300 before discharge of the concrete, unless otherwise specified.

b. Volumetric batching and continuous mixing at the site (Commonly referred to as mobile concrete mixers). Unless otherwise specified, volumetric batching and continuous mixing at the construction site will be permitted. The batching and mixing equipment shall conform to the requirements of ASTM C 685 and shall be demonstrated prior to placement of concrete, by tests with the job mix, to produce concrete meeting the specified proportioning and uniformity requirements. Concrete made by this method shall be produced, inspected, and documented in conformance with Sections 6, 7, 8, 13, and 14 of ASTM C 685.

c. Batch mixing at the site. This method of batching and mixing concrete shall be either (a) by batching and mixing all materials onsite by the use of paving mixers or stationary construction mixers, or (b) by using a combination of centrally batching a portion of the mix, transporting it to the site, and adding the remainder of materials and mixing onsite.

Paving mixers or stationary construction mixers and associated transport vehicles shall be in accordance with recommended practices for central-mixed concrete above. The time for mixing a batch of concrete in the mixer drum shall be according to manufacturer's recommendations but not less than 1 minute plus 1/4 minute for each cubic yard of concrete being mixed (8 cy batch = 3 minutes).

When a combination of centrally batching and transporting materials to the site and adding remainder of materials onsite is used, the Contractor shall prepare a written plan detailing how the batching and mixing of the concrete materials will be accomplished and controlled. This written batching and mixing plan shall be submitted to the Engineer for review and approval not less than 10 working days prior to the placement of concrete. The volume of the mixed concrete in a truck mixer shall not exceed 63% of the gross volume of the drum.

The Contractor shall furnish the Engineer for each batch of fresh concrete a batching ticket showing: the type, brand and amount of cement; the type, name, and amount of each admixture; total water added to the batch which includes free water on the aggregate; maximum size of aggregate; the type and dry weight of fine aggregate; the type and dry weight of coarse aggregate; the time of loading (the time that water was introduced to the cement); and the time the load was discharged.

7. FORMS

Forms shall be of good quality wood, plywood, steel or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete will conform to the specified dimensions and contours. Form surfaces shall be smooth and free from holes, dents, sags or other irregularities and maintained in this condition throughout the work. Forms shall be coated with a nonstaining form release agent before being set into place. Acceptable tolerances for formed structure members are specified in Section 23.

When a superplasticized concrete mix is used, forms shall be coated, according to the manufacturer's recommendations, with a form release agent that is specifically formulated for plasticized concrete. Forms shall be designed to withstand the increased pressures of the superplasticized concrete and the increase impact forces resulting from larger drop heights used in placing the superplasticized concrete.

Metal ties or anchorages which will be embedded in the concrete shall be equipped with cones, she-bolts or other devices that permit their removal to a depth of at least one inch without injury to the concrete. Ties designed to break off below the surface of the concrete shall not be used without cones. If approved fiberglass or plastic form ties are used, the tie ends shall be cut flush with the finished concrete and ground smooth.

All edges that will be exposed shall be chamfered, unless finished with molding tools as specified in Section 18.

8. PREPARATION OF FORMS AND SUBGRADE

Prior to placement of concrete, the forms, embedments, and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any form release agent on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed.

Rock surfaces shall be cleaned by high pressure air-water cutting, sandblasting or wire brush scrubbing, as necessary, and shall be wetted immediately prior to placement of concrete. Earth surfaces shall be firm and damp. Placement of concrete on mud, dried earth, noncompacted fill or frozen subgrade will not be permitted. All ice, snow and frost shall be removed and the temperature of all surfaces, including the reinforcing steel and other steel inclusions, to be in contact with the new concrete shall be no colder than 40°F.

Items to be embedded in the concrete shall be positioned accurately and anchored firmly.

Weepholes in walls or slabs shall be formed with nonferrous materials.

9. CONVEYING

Concrete shall be delivered to the site and discharged completely into the forms within 1-1/2 hours or before the drum of truck has revolved a total of 300 revolutions, whichever comes first, after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85°F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes.

Superplasticized concrete can be conveyed and placed when the temperature of the concrete is below 95°F and the slump of the concrete remains within the allowable slump range.

The Engineer will allow an appropriate extension of time when the setting time of the concrete is increased a corresponding amount by the addition of an approved admixture. In any case, concrete shall be conveyed from the mixer to the forms as rapidly as practicable, by methods that will prevent segregation of the aggregates or loss of mortar.

10. PLACING

Concrete shall not be placed until the subgrade, forms, steel reinforcement, and other embedments have been inspected and approved by the Engineer. For walls and columns, subsequent higher placements of concrete shall not be placed until the concrete below the new placement has gained sufficient strength to support the concrete dead load and any superimposed loads without distress. Placement sequences and timing shall consider form removal timing covered in Section 16.

If a placement plan is required in Section 25, concrete shall not be placed until the placement plan has been reviewed and approved by the Engineer.

The Contractor shall have all equipment and materials required for curing available at the site ready for use before placement of concrete begins.

Concrete shall be placed only in the presence of the Engineer. The Contractor shall give reasonable notice to the Engineer prior to each placement. Such notice shall be far enough in advance to give the Engineer adequate time to assure that the subgrade, forms,

steel reinforcement and other preparations comply with specifications. Other preparations include, but are not limited to, the concrete batching plant, mixing and delivery equipment and system, placing and finishing equipment and system, schedule of work, work force and heating or cooling facilities as applicable. All deficiencies are to be corrected before concrete is delivered for placing.

Concrete shall be placed and consolidated in a manner that will prevent segregation of the mix components. The concrete shall be deposited as closely as possible to its final position in the forms and shall be worked into the corners and angles of the forms and around all reinforcement and embedded items in a manner to prevent segregation of aggregates or excessive laitance. The depositing of concrete shall be regulated so that the concrete can be consolidated with a minimum of lateral movement. Concrete placed against sloping surfaces shall start at the lowest elevation and work upwards to the highest elevation.

Concrete other than architectural concrete shall not be dropped more than 5 feet vertically unless suitable equipment is used to prevent segregation. Architectural concrete shall not be dropped more than 3 feet vertically unless suitable equipment is used to prevent segregation. When a superplasticized concrete mix is used, concrete other than architectural concrete shall not be dropped more than 12 feet vertically and architectural concrete shall not be dropped more than 10 feet vertically unless suitable equipment is used to prevent segregation.

11. LAYERS

Slab concrete shall be placed to design thickness in one continuous layer, unless otherwise specified.

Formed concrete shall be placed in horizontal layers not more than 20 inches deep. When a superplasticized concrete mix is used, formed concrete may be placed in horizontal layers not more than 5 feet deep.

Successive layers of fresh concrete between construction joints shall be placed at a rate fast enough that the preceding layer is still plastic and can be easily mixed with the fresh concrete such that seams ("cold joints") or plane of weakness will not occur. If the surface of a previously placed layer of concrete has taken a set to the degree that it will not flow and mix with the succeeding layer when vibrated, the Contractor shall discontinue placing concrete and shall make a construction joint according to the procedure specified in Section 13. If placing is discontinued when a layer is incomplete, the ends of the incomplete layer shall be formed by a vertical bulkhead.

12. CONSOLIDATING

All concrete shall be consolidated with internal type mechanical vibrators capable of transmitting vibration to the concrete at frequencies not less than 8000 impulses per minute, unless otherwise specified or approved prior to placement. Vibration shall be supplemented by spading, rodding, and hand tamping, as necessary to insure smooth and dense concrete along form surfaces, in corners, and around embedded items. The Contractor shall provide a sufficient number of vibrators to properly consolidate the concrete immediately after it is placed. A sufficient number of standby vibrators shall be kept onsite during the placement of concrete.

Vibration shall compact the concrete and bring it into intimate contact with the forms, reinforcing steel, and other embedded items while removing voids and pockets of entrapped air. The location, insertion, duration, and removal of the vibrators shall be

such that maximum consolidation of the concrete is achieved without causing segregation of the mortar and coarse aggregate or causing water or cement paste to flush to the surface. Vibration shall be applied to the freshly deposited concrete by rapidly inserting the vibrator and slowly in an up and down motion removing the vibrator at points uniformly spaced at not more than 1-1/2 times the radius of the area visibly effected by vibration. Generally, rapidly inserting the vibrator and removing the vibrator with an up and down motion at 5 to 10 seconds per foot on 14 inch spacings or less. The area visibly effected by the vibrator shall overlap the adjacent, just vibrated area. The vibrator shall extend vertically into the previously placed layer of fresh concrete by at least 6 inches, at all points, to insure effective bond between layers. In thin slabs, the vibrator(s) should be sloped toward the horizontal to allow operations in a fully embedded position.

Vibration shall not be applied directly to the reinforcement steel, the forms, or other embedded items, unless otherwise specified. Vibration shall not be applied to concrete that has hardened to the degree that it does not become plastic when vibrated. If surface vibrators are used, surface vibrators may contact forms when consolidating thin slabs.

The use of vibrators to transport concrete in the forms or conveying equipment will not be permitted.

Surface vibrators may be used to consolidate thin slabs 8 inches and less in thickness. For slabs greater than 8 inches in thickness, the slab shall be consolidated with internal vibration and may be augmented through use of surface vibrators; such as, vibrating screeds, plate or grid vibratory tampers, or vibratory roller screeds. If concrete is to be consolidated using surface vibration methods, the Contractor shall detail in writing how this work is to be performed, including equipment selection and specifications, to the Engineer for review and approval not less than 30 calendar days prior to placing concrete by this method.

13. CONSTRUCTION JOINTS

Construction joints shall be made at the locations shown on the drawings, unless otherwise specified or approved by the Engineer. If construction joints are needed which are not shown on the drawings, they shall be placed in locations approved by the Engineer.

Where a feather edge would be produced at a construction joint, as in the top surface of a sloping wall, an insert form shall be used so that the resulting edge thickness on either side of the joint is not less than twice the maximum aggregate diameter used in the concrete mix.

Nonvertical construction joints in structural elements; such as, walls and columns, shall be consolidated and screeded to grade, unless otherwise specified. Construction joints shall be covered and wet cured for 7 days or until concrete placement resumes, unless otherwise specified.

Steel tying and form construction adjacent to concrete in-place shall not be started until the concrete has cured at least 12 hours. Before new concrete is deposited on or against concrete that has hardened, the forms shall be retightened. New concrete shall not be placed until the hardened concrete has cured at least 12 hours.

Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings, stains, or debris by washing and scrubbing with a wire brush or wire broom, or by other means approved by the Engineer. Immediately before new concrete is placed, all construction joints shall be wetted and standing water removed.

14. EXPANSION AND CONTRACTION JOINTS

Expansion and contraction joints shall be made only at locations shown on the drawings.

Exposed concrete edges at expansion and contraction joints shall be carefully tooled or chamfered, and the joints shall be free of mortar and concrete. Joint filler shall be fully exposed for its entire length with clean and true edges.

When open joints or weakened plane "dummy" joints are specified, joints formed in fresh concrete shall be constructed by the insertion and subsequent removal of a wood strip, metal plate or other suitable template in such a manner that the corners of the concrete will not be chipped or broken. The edges of the fresh concrete at the joints shall be finished with an edging tool prior to removal of the joint strips. Open joints or weakened plane "dummy" joints may also be saw-cut joints conforming to the depth and extent specified.

Preformed expansion joint filler shall be held firmly in the correct position as the concrete is placed.

15. WATERSTOPS

Waterstops shall be held firmly in the correct position as the concrete is placed. Joints in metal waterstops shall be brazed or welded. Joints in rubber or plastic waterstops shall be cemented, welded or vulcanized as recommended by the manufacturer. Joints shall be watertight and of a strength equivalent to that specified in Material Specification 537. Intersecting waterstop joints shall be prefabricated and supplied by the same manufacturer providing the waterstop.

16. REMOVAL OF FORMS, SUPPORTS, AND PROTECTIVE COVERINGS

Forms, supports, and protective coverings shall be removed as soon as practical after the concrete has gained sufficient strength to support its own weight and superimposed loads. Removal shall be done in a manner that will not damage the concrete surface nor induce sudden or excessive stresses.

The minimum period from completion of the concrete placement to the removal of the forms shall be based on either Strength Tests or Cumulative Times.

Strength Tests. The strength of the in-place concrete will be determined by testing concrete cylinders specifically cast for this purpose and cured adjacent to the member in accordance with the ASTM C 31 method for determining removal time. Unless otherwise specified, forms supporting the weight of the concrete member may be removed after the concrete strength is 70% of that specified for the Class of concrete. Forms not supporting the weight of the concrete member or other superimposed loads may be removed after the concrete strength has reached the strength specified in Section 25.

Cumulative Time. The total accumulated time, not necessarily continuous, that the air adjacent to the concrete is above 50^{o}F and the specified concrete curing has occurred concurrently will be determined. Forms may be removed after the total accumulated time in the following table:

ACCUMULATED FORM REMOVAL TIMES		
Sides of Slabs or Beams		1/ 12 hours
Undersides of Slabs or Beams	Clear Span < 10 ft 10 - 20 ft > 20 ft	1/ 2/ 4 days 7 days 14 days
Sides of Walls or Columns	Height Above Form ≤ 10 ft ≤ 20 ft > 20 ft	1/ 3/ 4/ 12 hours 24 hours 72 hours

1/ Table values apply to normal concrete. Values for concrete which contains cements or admixtures that significantly retard or accelerate strength gain will be determined by the Engineer and based on actual design mix data.

2/ Values apply to members designed to support significant superimposed loads. Values for members designed for only self weight when placed in service shall be 50% greater.

3/ Values apply to members not subject to significant horizontal loads. Additional time or rebracing will be needed for members subject to significant wind or other horizontal loads.

4/ Subsequent higher lifts may be placed after 12 hours.

17. FINISHING FORMED SURFACES

All formed concrete surfaces shall be true and even, and shall be free from over-tolerance depressions, holes, projections, bulges, or other defects in the specified surface finish or alignment, unless otherwise specified in Section 25. Depressions are measured as the distance from the bottom of a 5 foot long template or straight edge.

Surfaces to be backfilled or otherwise concealed when construction is completed shall have the following surface treatment, unless otherwise specified: Repair defective concrete, fill all form tie holes, correct surface depressions deeper than 1 inch, and remove or smooth fins and abrupt projections that exceed 3/4 inch.

Surfaces to be permanently exposed, where other finishes are not specified, shall have the following treatment: Repair defective concrete, fill all form tie holes, remove or smooth all abrupt irregularities greater than 1/4 inch in depth or projection, and treat all depressions and irregularities such that they do not exceed 1/2 inch in depth.

Repair and filling of form bolt and tie holes, and other holes of similar size and depth shall be performed as specified in Section 20.

18. FINISHING UNFORMED SURFACES

All exposed surfaces of the concrete shall be accurately screeded to grade and then float finished, unless otherwise specified. The float finish shall result in a surface that has no irregularities that exceeds 1/4 inch when checked with a template or straight edge that is 10 feet long.

All exposed surfaces of concrete shall be accurately struck off to grade after placement and consolidation are completed. Following strike-off, the surfaces shall be immediately smoothed by darbying or bull floating before any free water has bled to the surface. The concrete shall then be allowed to rest until the bleed water and water sheen has left the surface and the concrete has stiffened to where it will sustain foot pressure with only about 1/4 inch indentation. At this time all joints and edges that will be exposed to view that are not chamfered shall be finished with edging tools. After edging and hand-jointing is complete, all exposed surfaces shall be floated with wood or magnesium floats. The floating should work the concrete no more than necessary to remove screed, edger and jointer marks and produce a compact surface, uniform in texture.

Water shall not be sprinkled or added to the surface of the concrete during the darbying, bull floating, floating, or other finishing operations to facilitate finishing.

19. CURING

Freshly placed concrete shall be cured a minimum of 7 days in accordance with the recommended practices set forth below. A curing process shall be started as soon as the concrete has hardened sufficiently to prevent surface damage. Curing concrete, including exposed surfaces of formed concrete and concrete in forms, shall be maintained at a satisfactory moisture content for at least 7 days following placement. If forms are removed prior to the end of the 7 day curing period, the interrupted curing process shall be re-established and maintained until a full 7 day curing period is achieved.

A satisfactory moisture condition is: (a) Continuous or frequent application of water or use of a saturated cover material; such as, canvas, cloth, burlap, earth, sand, etc., or (b) Prevention of excessive water loss from the concrete by use of an impermeable coating (curing compound) or covering (plastic, paper, etc.). The application of water or covering shall not erode, mar, or otherwise damage the concrete. Plastic film or paper shall meet the requirements of ASTM C 171. Black covering shall not be used when concreting in hot weather.

Except as otherwise specified in Section 25, curing compound may be used for exposed surfaces or formed surfaces after patching and repair have been completed. Unless otherwise specified, the curing compound shall be white pigmented and conform to ASTM C 309, Type 2, Class A or B. Clear curing compound (Type l) or clear with fugitive dye (Type 1-D) may be used only when specified in Section 25. Curing compounds shall not be used on surfaces that are to receive additional concrete, paint, tile, or other coatings unless the Contractor demonstrates that the membrane can be satisfactorily removed or can serve as a base for the later application.

Curing compound shall be thoroughly mixed before applying and agitated during application. Except as otherwise specified in Section 25, the compound shall be applied at a pressure of 75 to 100 psi using a continuously agitating pressure sprayer at a uniform rate of not less than one gallon per 175 square feet of surface. Manual hand pump sprayers shall not be used unless otherwise specified. For individual concrete placements or repairs having a surface areas of 400 square feet or less, curing compound may be applied with a soft-bristled brush, paint roller, or hand sprayer. The compound shall form

a uniform continuous, adherent film that shall not check, crack or peel and shall be free from pinholes or other imperfections.

All surfaces covered with curing compound shall be continuously protected from damage to the protective film during the required curing period.

Surfaces subjected to heavy rainfall or running water within 3 hours after the compound has been applied, or surfaces damaged by subsequent construction operations during the curing period shall be resprayed in the same manner as for the original application.

Water for curing shall be clean and free from any substances that will cause discoloration of the concrete.

20. CONCRETE PATCHING, REPAIR OR REPLACEMENT

Patching. All form bolts, metal ties, and similar forming restraints shall be removed to a depth of one inch below the surface of the concrete and their cavities repaired unless otherwise specifically permitted or specified. Small cavities, large air holes, minor honeycombed areas, and other superficial imperfections that require patching to meet the specified finish requirements shall be thoroughly cleaned and filled. Holes left by bolts or straps that pass through the concrete section shall be filled solid with a dense, well-bonded, nonshrink patching material. Dry-pack mortar and replacement concrete shall follow the appropriate procedure detailed in the Repair and Maintenance chapter of the Concrete Manual, Bureau of Reclamation, U.S. Department of the Interior. Proprietary patching materials shall be appropriate for the type of repair, used within the manufacturer's recommended limits, and applied according to the manufacturer's recommendations.

Repair or Replacement. The Contractor shall repair and/or replace concrete that does not meet the requirements of this specification. Prior to starting any repair or replacement work, the Contractor shall prepare a written plan for the repair or replacement. The primary reference for materials and repair methods for the plan shall be the appropriate sections of the Repair and Maintenance chapter of the Concrete Manual, Bureau of Reclamation, U.S. Department of the Interior. The repair plan shall be submitted to the Engineer for review at least ten days prior to any repair or replacement work. Approval of the plan will be authorized in writing by the Contracting Officer.

When proprietary patching materials are proposed in the plan, the manufacturer's data sheets and written recommendations shall be included in the plan.

Repair materials or replacement concrete shall have properties, color, and texture similar to and compatible with the concrete being repaired or replaced. Repair or replacement concrete work shall be performed only when the Engineer is present.

Curing of repaired or replaced concrete shall be started immediately after finish work is completed and as specified in Section 19 or as specified by the manufacturer of proprietary compounds.

21. CONCRETING IN COLD WEATHER

Methods for concreting in cold weather shall be performed when, for more than 3 consecutive days, the following conditions exist: (a) the average daily air temperature at the job site is less than 40^{o}F and (b) the air temperature at the job site is not greater than 50^{o}F for more than one-half of any 24-hour period. The average daily air temperature is

the average of the highest and lowest temperatures occurring during the period from midnight to midnight.

Concrete shall be protected against freezing during the first 24 hours after placement whether or not the average weather conditions specified above for cold weather concreting exist.

The following provisions also shall apply, unless otherwise specified:

a. When the cement is added to the mix, the temperature of the mixing water shall not exceed 140°F nor shall the temperature of the aggregate exceed 150°F.

b. The temperature of the concrete at the time of placing shall be within the placement temperature range shown below, unless otherwise specified.

Lease dimension of Section, inches	Placement Temperature, °F
Less than 12	55 - 75
12 to 36	50 - 70
36 to 72	45 - 65
Greater than 72	40 - 60

c. The minimum temperature of the concrete for the first 72 hours after placement shall not be less than the minimum temperature shown above. Concrete structures shall be immediately protected after concrete placement by methods of covering, housing, insulating, or heating concrete structures that will be sufficient to maintain the minimum temperature adjacent to the concrete surface. If the minimum temperature requirements are not met and the concrete did not freeze, the protection time will be extended a period equal to twice the number of hours the temperature was below the minimum temperature.

d. Exhaust flue gases from combustion heaters shall be vented to the outside of the enclosure. The heat from heaters and ducts shall be directed in such a manner as to not overheat or dry the concrete in localized areas or to dry exposed concrete surfaces.

e. At the end of the protection period, the concrete shall be allowed to cool gradually. The maximum decrease at the concrete surface in a 24-hour period shall not exceed 40^{o}F.

22. CONCRETING IN HOT WEATHER

Methods for concreting in hot weather shall be in accordance with the requirements set forth below.

For the purpose of this specification, hot weather is defined as any combination of the following conditions that impair the quality of freshly mixed or hardened concrete by accelerating the rate of moisture loss and rate of cement hydration, or otherwise resulting in detrimental results:

*** High ambient temperature
*** High concrete temperature
*** Low relative humidity
*** Wind velocity
*** Solar radiation.

Whenever the above conditions exist or when climatic conditions are such that the temperature of the concrete may reasonably be expected to exceed 90°F at the time of delivery to the work site or during the placement operations, the following provisions shall apply:

a. The Contractor shall maintain the temperature of the concrete below 90°F during mixing, conveying, and placing.

b. Exposed concrete surfaces which tend to dry or set too rapidly shall be continuously moistened by means of fog sprays or other means to maintain adequate moisture during the time between placement and finishing. Water shall not be sprinkled or added directly to the surface of the concrete prior to finishing.

c. Finishing of slabs and other exposed surfaces shall be started as soon as the condition of the concrete allows and shall be completed without delay. Water shall not be sprinkled or added to the surface of the concrete during the darbying, bull floating, floating, or other finishing operations to facilitate finishing.

d. Formed surfaces shall be kept completely and continuously wet from the time the concrete takes initial set to when the forms are removed. After the forms are removed, the concrete surfaces shall be kept completely and continuously wet for the duration of the curing period or until curing compound is applied in accordance to Section 21.

e. Exposed and unformed concrete surfaces, especially flat work placed with large areas of surface, shall be kept completely and continuously wet for the duration of the curing period or until curing compound is applied in accordance to Section 19. The concrete shall be protected against thermal shock from rapid cooling (5°F per hour or more than 40°F per 24-hour period) of the concrete by application of curing water or temperature changes during the first 24 hours of the curing period.

f. When any single or combination of conditions may result in very rapid setting or drying of the concrete, extreme conditions exist. For flat work and slab construction, extreme conditions exist when the evaporation rate exceeding 0.2 $lb/ft^2/hr$.

The Engineer may (1) restrict placement to the most favorable time of the day, (2) restrict the depth of layers to assure coverage of the previous layer while it will still respond readily to vibration, (3) suspend placement until conditions improve, and (4) restrict the removal of forms, repair, and patching to small areas which can be protected with curing compound immediately.

The evaporation rate for flat work and slab construction may be determined by calculating the evaporation rate from a shallow cake pan having a surface area of at least 1 square foot or by other methods approved by the Engineer or designated in Section 25.

23. ACCEPTANCE OF THE CONCRETE WORK

Acceptance of the concrete work will be a cumulative acceptance process based upon progressively meeting the requirements of the specifications and drawings for:

*** Fresh concrete,
*** Concrete strength and durability,
*** Structure dimensions, and
*** Structure appearance.

Fresh Concrete

Fresh concrete conforming to the mix proportions and quality requirements of the approved job mix and the handling and placement requirements of previous sections will be satisfactory.

Concrete Strength

A strength test is the average of the compressive strengths of two standard cured cylinders prepared and tested in accordance with Section 4, unless otherwise specified. The strength of the hardened concrete will be satisfactory if the following requirements are met:

a. If Method 1 from Section 3 is specified and the concrete work is less than 75 total cubic yards for the class of concrete specified, the compressive strength of the concrete will be satisfactory if no individual strength test falls more than 500 psi below the specified compressive strength (**f 'c**) for the respective class of concrete.

b. If Method 1 from Section 3 is specified and the concrete work is 75 total cubic yards or more for the class of concrete specified, the compressive strength of the concrete will be satisfactory if both of the following requirements are met:

(1) No individual strength test falls more than 500 psi below the specified compressive strength (**f 'c**) for the class of concrete specified.

(2) The average of any three consecutive strength tests is not less than the specified compressive strength (**f 'c**) two or more consecutive times for the class of concrete specified.

The Contractor shall take steps to increase the average of subsequent strength tests when the average of any three consecutive strength tests falls below the specified concrete strength (**f 'c**).

c. The Engineer will determine the structural adequacy and evaluate the durability of the in-place concrete when the concrete strength based on the standard cured concrete cylinders is unsatisfactory. The Engineer will determine the need for additional quality assurance testing.

d. The Contractor may core the concrete, have the cores tested by a certified testing laboratory at the Contractor's expense, and submit test results to the Engineer for consideration and evaluation of concrete strength adequacy when the concrete strength based on the standard cured concrete cylinders is unsatisfactory.

e. Sampling and testing concrete by coring shall conform to Section 4. The strength of the concrete based upon concrete cores will be satisfactory if both of the following requirements are met:

(1) The average compressive strength of the three cores equal or exceed 85 percent of the specified compressive strength (**f 'c**).

(2) The compressive strength of any individual core does not fall below 75 percent of the specified compressive strength (**f 'c**).

f. If Method 2 from Section 3 is specified, the Engineer is responsible for the concrete job mix design and the quality concrete that results from the job mix.

The hardened concrete will be satisfactory if the required batch tickets or other documentation acceptable to the Engineer clearly show that the batch ingredients and weights of each ingredient including all admixtures conforms to the job mix provided by the Engineer. Random periodic inspection of the batching operations may be made by the Engineer to verify that ingredients and ingredient proportions conform to the batching documentation.

If the concrete ingredients, proportions, or admixtures varies from the job mix provided by the Engineer, the concrete may be rejected if, in the judgment of the Engineer, the variance will significantly affect the strength or durability of the concrete or will adversely affect the life expectancy or other components of the structure.

Structure Dimensions and Appearance

The appearance of the concrete shall meet the requirements of Sections 17 and 18.

The dimensions of formed members, unless otherwise specified, will be satisfactory if they conform to the requirements of the specifications, the locations shown on the drawings, and are within acceptable tolerances below:

a. Variation from plumb for walls and column shall be not more than 0.2% of the wall or column height.

b. Variation from specified elevations for slabs, floors, or other horizontal members shall be not more than 0.2% of the length of the member in the direction of grade.

c. Variations in the cross-sectional dimensions of columns and beams and in the thickness of walls and above-grade slabs shall not be more than minus 1/4 inch or plus 1/2 inch from the shown dimensions.

24. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, concrete will be measured to the neat lines or pay limits shown on the drawings, and the volume of concrete will be computed to the nearest 0.1 cubic yard. No deduction in volume will be made for chamfers, rounded or beveled edges, or for any void or embedded item that is less than five cubic feet in volume. Where concrete is placed against the sides or bottom of an excavation without intervening forms, drainfill, or bedding, the volume of concrete required to fill voids resulting from overexcavation outside the neat lines or pay limits will be included in the measurement for payment where such overexcavation is directed by the Engineer to remove unsuitable foundation material; but only to the extent that the unsuitable condition is not a result of the Contractor's improper construction operations, as determined by the Engineer.

Method l Payment for each item of concrete will be made at the contract unit price for that item. The payment for concrete will constitute full compensation for completion of the concrete work, including joint fillers, waterstops, dowels or dowel assemblies and metal plates, but not including reinforcing steel or other items listed for payment elsewhere in the contract.

Method 2 Payment for each item of concrete will be made at the contract unit price for that item. The payment for concrete will constitute full compensation for completion of the concrete work, including joint fillers, waterstops, metal plates, dowels, and other assemblies, but not including furnishing and placing reinforcing steel or furnishing and handling cement or other items listed for payment elsewhere in the contract.

Cement will be measured by dividing the volume of concrete accepted for payment by the yield of the applicable job mix. The yield will be determined by the procedure specified in ASTM C 138. If the amount of cement actually used per batch exceeds the amount in the job mix specified by the Engineer, the measurement will be based on the amount of cement specified by the Engineer for the job mix. Unless otherwise stated in Section 25, a bag of cement will be considered 94 pounds. Payment for each type of cement will be made at the contract unit price for furnishing and handling that type of cement and such payment will constitute full compensation for furnishing and handling the cement.

All Methods The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is make subsidiary. Such items and the items to which they are made subsidiary are identified in Section 25 of this specification.

25. ITEM OF WORK AND CONSTRUCTION DETAILS

Cement shall be Type I. The air-entraining admixture shall be batched in solution in a portion of the mixing water. The water-reducing, set-retarding admixture used shall be Type D. Bituminous type expansion joint filler is permitted. Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 10, Concrete, Class 4000

(1) This item shall consist of furnishing and placing concrete in the riser, monument, drawdown inlet, bedding and impact basin.

(2) Concrete mix design shall be method 1.

(3) The slump shall be 4 inches $\pm$ 1 inch for all concrete.

(4) Chamfer all exposed concrete edges ¾ inch.

(5) Side forms for the bedding shall not be earth.

(6) The top surface of the drainfill in the vicinity of the principal spillway shall be covered with a layer of geotextile as specified for R/C pipe joints or equivalent as needed to prevent contamination of drainfill. Prior to backfill of the principal spillway, geotextile or equivalent shall be removed except for that which is under concrete.

(7) Coarse aggregate conforming to ASTM C-33 shall be size 57, 67, or 467. It is permissible to use Gradation A, B, or D as shown in Section 1005, Aggregates for Concrete, Missouri Standard Specifications for Highway Construction.

(8) Measurement and payment shall be by Method 1.

b. Bid Item 24, Concrete, Class 4000, Core Trench

(1) This item shall consist of the placement of slurry or dental concrete on rock surfaces in the core trench as specified in Construction Specification 63.

(2) Measurement and payment shall be to the nearest 0.1 cubic yard of concrete delivered and properly placed to treat rock surfaces.

(3) The provisions of Section 25.a.(2), (3) and (7) of this specification shall also apply.

(4) Item of work subsidiary to Bid Item 24 is:

(a) Treatment of Rock Surfaces – Construction Specification 63

CONSTRUCTION SPECIFICATION

34. STEEL REINFORCEMENT

1. SCOPE

The work shall consist of furnishing and placing steel reinforcement for reinforced concrete or pneumatically applied mortar.

2. MATERIALS

Steel reinforcement shall conform to the requirements of Material Specification 539. Before reinforcement is placed, the surfaces of the bars and fabric and any metal supports shall be cleaned to remove any loose, flaky rust, mill scale, oil, grease or other undesirable coatings or foreign substances. Epoxy-coated steel reinforcement shall be free of surface damage. After placement, the reinforcement shall be maintained in a clean and serviceable condition until it is completely embedded within the concrete.

3. BAR SCHEDULE, LISTS AND DIAGRAMS

Any supplemental bar schedules, bar lists or bar-bending diagrams required in Section 10 of this specification to accomplish the fabrication and placement of steel reinforcement shall be provided by the Contractor. Prior to placement of reinforcement, the Contractor shall furnish four copies of any such lists or diagrams to the Engineer for approval. Acceptance of the reinforcement will not be based on approval of these lists or diagrams, but will be based on inspection of the steel reinforcement after it has been placed, tied, supported and ready to receive concrete.

4. BENDING

Reinforcement shall be cut and bent in compliance with the requirements of the American Concrete Institute Standard 315. Bars shall not be bent or straightened in a manner that will injure or weaken the material. Bars with kinks, cracks or improper bends will be rejected.

5. SPLICING BAR REINFORCEMENT

Splices of reinforcement shall be made only at locations shown on the drawings and provided by the steel schedule. Placement of bars at the lap splice locations shown, when not in contact, shall not be farther apart than one-fifth (1/5) the shown lap length and in any case no greater than six (6) inches.

6. SPLICING WELDED WIRE FABRIC

Unless otherwise specified, welded wire fabric shall be spliced in the following manner:

a. Adjacent sections shall be spliced end to end (longitudinal lap) by overlapping a minimum of one full mesh plus two (2) inches plus the length of the two end overhangs. The splice length is measured from the end of the longitudinal wires in one piece of fabric to the end of the longitudinal wire in the lapped piece of fabric.

b. Adjacent sections shall be spliced side to side (transverse lap) a minimum of one full mesh plus two (2) inches. The splice length shall be measured from the

centerline of the first longitudinal wire in one piece of fabric to the centerline of the first longitudinal wire in the lapped piece of fabric.

7. PLACING

Reinforcement shall be accurately placed and secured in position in a manner that will prevent its displacement during the placement of concrete. Tack welding of bars will not be permitted. Metal chairs, metal hangers, metal spacers and concrete chairs may be used to support the reinforcement. Metal hangers, spacers and ties shall be placed in such a manner that they will not be exposed in the finished concrete surface. The legs of metal chairs or side form spacers that may be exposed on any face of slabs, walls, beams or other concrete surfaces shall have a protective coating or finish by means of hot dip galvanizing, epoxy coating, plastic coating, or be stainless steel. Metal chairs and spacers not fully covered by a protective coating or finish shall have a minimum cover of 3/4 inch of concrete over the unprotected metal portion except for those with plastic coatings may have a minimum cover of 1/2 inch of concrete over the unprotected metal portion. Pre-cast concrete chairs shall be manufactured of the same class of concrete as specified for the structure and shall have the tie wires securely anchored in the chair or a V-shaped groove at least 3/4 inch in depth molded into the upper surface to receive the steel bar at the point of support. Pre-cast concrete chairs shall be clean and moist at the time concrete is placed.

High density or structural plastic rebar accessories, designed to insure maximum concrete bond, may be substituted for metal or concrete accessories in spacer applications as approved by the Contracting Officer. Exposure of plastic rebar accessories at the finished concrete surface shall be kept to a minimum. Plastic rebar accessories, when used, shall be staggered along adjacent parallel bars and shall be placed at intervals no closer than twelve (12) inches. Plastic rebar accessories shall not be used in concrete section six (6) inches or less in thickness.

Reinforcement shall not be placed until the prepared site has been inspected and approved. After placement of the reinforcement, concrete shall not be placed until the reinforcement has been inspected and approved by the Engineer.

8. STORAGE

Steel reinforcement stored at the work site shall be placed on platforms, skids or other supports and in a manner that contact with the ground is avoided and be protected from mechanical damage and/or corrosion.

9. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the weight of bar reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest pound by computation from the placing drawings. Measurement of hooks and bends will be based on the requirements of ACI Standard 315. Computation of weights of bar reinforcement will be based on the unit weights established in Table 34-1 of this specification. The weight of steel reinforcing in extra splices or extra length splices approved for the convenience of the Contractor or the weight of supports and ties will not be included in the measurement for payment.

The area of welded wire fabric reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest square foot by computation from the placing drawings with no allowance for required laps.

Payment for furnishing and placing bar reinforcing steel will be made at the contract unit price for bar reinforcement. Payment for furnishing and placing welded wire fabric reinforcing steel will be made at the contract unit price for welded wire fabric reinforcement. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work including preparing and furnishing bar schedules, lists or diagrams; furnishing and attaching ties and supports; and furnishing, transporting, cutting, bending, cleaning, and securing all reinforcement.

Compensation for any item of work described in the contract, but not listed in the bid schedule, will be included in the payment for the item of work to which it is made subsidiary. Such items to which they are made subsidiary are identified in Section 10 of this specification.

TABLE 34-1. STANDARD REINFORCING BARS

Bar Size No.	Weight (lb./ft.)
3	0.376
4	0.668
5	1.043
6	1.502
7	2.044
8	2.670
9	3.400
10	4.303
11	5.313
14	7.650
18	13.600

TABLE 34-2. RECTANGULAR WELDED WIRE FABRIC

Style Designation		Weight
By Steel Wire Gauge	By W-Number	(lb./100 Sq. Ft.)
6 x 6 - 10 x 10	6 x 6 - W1.4 x W1.4	21
6 x 6 - 8 x 8	6 x 6 - W2.1 x W2.1	30
6 x 6 - 6 x 6	6 x 6 - W2.9 x W2.9	42
6 x 6 - 4 x 4	6 x 6 - W4.0 x W4.0	58
4 x 4 - 10 x 10	4 x 4 - W1.4 x W1.4	31
4 x 4 - 8 x 8	4 x 4 - W2.1 x W2.1	44
4 x 4 - 6 x 6	4 x 4 - W2.9 x W2.9	62
4 x 4 - 4 x 4	4 x 4 - W4.0 x W4.0	85
4 x 12 - 8 x 12	4 x 12 - W2.1 x W0.9*	25
4 x 12 - 7 x 11	4 x 12 - W2.5 x W1.1*	31

NOTE: Style Designation is defined in ACI Standard 315 of the American Concrete Institute.

*Welded smooth wire fabric with wires smaller than Size W1.4 is manufactured from galvanized wire.

10. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 11, Steel Bar Reinforcement

(1) This item shall consist of furnishing and placing the steel reinforcement required in the construction of the reinforced concrete.

CONSTRUCTION SPECIFICATION

41. REINFORCED CONCRETE PRESSURE PIPE CONDUITS

1. SCOPE

The work shall consist of furnishing and installing reinforced concrete pressure pipe conduits, fittings and accessories as shown on the drawings and/or specified herein.

2. MATERIALS

Reinforced concrete pressure pipe, fittings and accessories shall conform to the requirements of Material Specification 541.

Portland cement concrete for bedding and cradles shall conform to the requirements of Construction Specification 31 - Concrete for Major Structures or Construction Specification 32 - Structure Concrete.

Joint sealing compound shall conform to the requirements of Material Specification 536.

Preformed expansion joint filler shall conform to the requirements of Material Specification 535.

Filter Fabric shall conform to Material Specification 592.

3. LAYING THE PIPE

The pipe shall be set to the specified line and grade and temporarily supported on pre-cast concrete blocks or wedges. Concrete blocks and wedges used to temporarily support the pipe during placement of concrete bedding and/or cradle shall be of a class of concrete equal to or stronger than the concrete used to construct the bedding and/or cradle. Bell and spigot pipe shall be laid with the bells or grooves facing upstream unless otherwise specified in Section 7 or shown on the drawings. When pre-cast pipe risers and other similar pre-cast pipe structures are installed prior to pipe installation, pipe may be installed in the downstream direction with the belled end upstream. Adequate bell clearance in the subgrade/bedding shall be provided.

Just before each joint is connected the connecting surfaces of the bell and spigot or spigots and sleeve shall be thoroughly cleaned and dried, and the rubber gasket and the inside surface of the bell or sleeve shall be lubricated with a light film of soft vegetable soap compound (flax soap). The rubber gasket shall be stretched uniformly as it is placed in the spigot groove to insure a uniform volume of rubber around the circumference of the pipe.

The joint shall be connected by means of a pulling or jacking force so applied to the pipe that the spigot enters squarely into the bell.

When the spigot has been seated to within 1/2 inch of its final position, the position of the gasket in the joint shall be checked around the entire circumference of the pipe by means of a metal feeler gauge. In any case where the gasket is found to be displaced, the joint shall be disengaged and properly reconnected. After the position of the gasket has been checked, the spigot shall be completely pulled into the bell and the section of pipe shall be adjusted to line and grade.

4. FILLING JOINTS

Before the placement of the bedding or cradle, the exterior annular space between the ends of the pipe sections shall be cleaned and completely filled with joint sealing compound. Before the compound is applied, the surfaces against which it is to be placed shall be cleaned of all dust, lubricant and other substances that would interfere with a bond between the compound and the pipe. If recommended by the manufacturer of the compound, the concrete surfaces shall be coated with a primer in accordance with the manufacturer's recommendations. Primers shall be applied to the concrete surfaces only and shall not come in contact with the gasket or gasket sealing surfaces. Unless the compound or primer is specifically recommended for use on moist concrete, the surfaces shall be dry when it is applied.

The joint sealing compound shall be allowed to cure until it is sufficiently firm to prevent the entry of concrete or earth into the joint. Unless otherwise specified in Section 7 of this specification, prior to placing bedding or earth backfill (excluding concrete) containing particles larger than one-fourth inch in maximum dimension within 6 inches of the joint sealing compound, the compound shall be covered by a minimum of 2-foot wide, 4-ply thickness of filter fabric. Filter fabric shall be wrapped completely around the joint and overlapped a minimum of 12-inches at the top of the pipe. Lap shall be securely fastened to ensure filter fabric fits snugly during backfill operations. Filter fabric to be centered on the joint. Filter fabric shall conform to Material Specification 592, Table 2 Non-woven, Class II.

5. PRESSURE TESTING

Pressure testing of the completed conduit will not be required.

6. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the quantity of each size, type and class of pipe will be determined as the sum of the nominal laying lengths of the pipe sections used. Payment for each size, type and class of reinforced concrete pressure pipe will be made at the contract unit price for that size, type and class of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe complete in place including accessories such as wall fittings, joint gaskets, coupling bands, sleeves or collars and all other items necessary and incidental to the completion of the work, except the special fittings and appurtenances listed separately in the bid schedule. Payment for each special fitting and appurtenance will be made at the contract price for that type and size of fitting and appurtenance.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

7. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 12, Prestressed Concrete Pressure Pipe, 30" Diameter
Bid Item 13, Prestressed Concrete Pressure Pipe, 16" Diameter

(1) This item shall consist of furnishing and installing the prestressed concrete pressure pipe for the principal spillway and drawdown assembly as shown on the drawings.

(2) The pipe shall be laid in an upstream direction starting at the outlet end.

(3) The pipe joints shall be covered by a minimum of 2-foot wide, 4-ply thickness of filter fabric. The filter fabric shall be wrapped completely around joint and overlapped a minimum of 12 inches at the top of the pipe. The lap shall be securely fastened to ensure the filter fabric fits snugly during backfill operations. The filter fabric is to be centered on the joint. Filter fabric shall conform to Material Specification 592, Table 2, Non-Woven, Class II. The 4-ply thickness was based on filter fabric weighting 6 ounces per square yard per ply. The number of plies can be reduced accordingly for heavier filter fabric.

CONSTRUCTION SPECIFICATION

45A. PLASTIC PIPE FOR DRAINS

1. SCOPE

The work shall consist of furnishing and installing plastic pipe, except corrugated polyethylene tubing, and the necessary fittings and appurtenances as shown on the drawings or as specified herein.

2. MATERIAL

Pipe, fittings, and gaskets shall conform to the requirements of Material Specification 547 and as specified in Section 14 of this specification or as shown on the drawings.

Perforated pipe shall conform to the requirements of Material Specification 547 and as specified in Section 14 of this specification or as shown on the drawings.

Unless otherwise specified, concrete shall conform to the requirements of Construction Specification 32, Structure Concrete, and Section 8 of this specification.

Unless otherwise specified, earth backfill shall conform to the requirements of Construction Specification 23, Earthfill.

Unless otherwise specified, drainfill shall conform to the requirements of Construction Specification 24, Drainfill.

3. HANDLING AND STORAGE

Pipe shall be delivered to the job site and handled by means which provide adequate support to the pipe and do not subject it to undue stresses or damage. When handling and placing plastic pipe, care shall be taken to prevent impact blows, abrasion damage, and gouging or cutting (by metal edges and/or surfaces or rocks). All special handling requirements of the manufacturer shall be strictly observed. Special care shall be taken to avoid impact when the pipe must be handled at temperatures of 40° F or less.

Pipe shall be stored on a relatively flat surface so that the barrels are evenly supported. Unless the pipe is specifically manufactured to withstand exposure to ultraviolet radiation, it shall be covered with an opaque material when stored outdoors for period of fifteen days or longer.

4. EXCAVATION

Excavation shall be in accordance with Construction Specification 21, Excavation, and Section 14 of this specification or as shown on the drawings.

The pipe foundation shall be excavated a minimum of four inches lower than the pipe grade shown on the drawings or staked in the field whenever bedrock, boulders, cobbles, or other materials that may cause pipe damage are encountered at planned pipe grade.

5. LAYING THE PIPE

Plastic pipe conduits complete with fittings and other related appurtenances shall be installed to the lines and grades shown on the drawings or specified in Section 14 of this specification. The pipe shall be installed so that there is no reversal of grade between joints unless otherwise shown on the drawings. The pipe shall not be dropped or dumped on the bedding or into the pipe trench. The ground surface near the pipe trench shall be free of loose rocks and stones greater than one (1) inch in diameter to ensure that rock will not be displaced and impact the pipe.

Just prior to placement, each pipe section shall be inspected to insure that all foreign materials are removed from the inside of the pipe. The pipe ends and the couplings shall be free of foreign material when assembled. At the completion of a work shift, all open ends of the pipeline shall be temporarily closed off by a suitable cover or plug.

Care shall be taken to prevent distortion and damage during periods of hot or cold weather. During unusually hot weather (day-time high temperatures greater than 90° F), the pipe assembled in the trench shall be lightly backfilled or shaded to keep it as near to ground temperature as possible until final backfill is placed. Backfill operations should be performed during daily construction periods when the ground temperature and the temperature of the pipe does not vary more than 40° F.

Perforated pipe shall be installed with the perforations down and oriented symmetrically about the vertical centerline. Perforations shall be clear of any obstructions on the inside and outside of the pipe when the pipe is approved by the Engineer for backfill.

During installation, the pipe shall be firmly and uniformly bedded throughout its entire length, to the depth and in the manner specified in Section 14 of this specification or as shown on the drawings. Bell-holes shall be placed in bedding material under bells, couplings and other fittings to assure the pipe is uniformly supported throughout its entire length. Blocking or mounding beneath the pipe to bring the pipe to final grade will not be permitted.

6. PIPE EMBEDMENT

Earth Bedding.

The pipe shall be firmly and uniformly placed on compacted earthfill bedding or an in-place earth material bedding of ample bearing strength to support the pipe without noticeable settlement. The earth material on which the pipe is placed shall be of uniform density to prevent differential settlement.

Unless otherwise specified, a groove that closely conforms to the outside surface of the pipe shall be formed in the bedding. The depth of the groove shall be equal to or greater than 0.3 of the pipe diameter.

Earth bedding shall be compacted to a density not less than adjacent undisturbed in-place earth materials or be compacted earth backfill. Earthfill materials used for compacted earth bedding shall be free of rocks or stones greater than one (1) inch in diameter and earth clods greater than two (2) inches in diameter. The pipe shall be loaded sufficiently during the compaction of bedding under the haunches and around the sides of the pipe to prevent displacement from its final approved placement.

Pipe Encased in Drainfill.

The pipe shall be firmly and uniformly placed on a bedding of specified drainfill. Drainfill shall be placed and compacted as specified in Section 14 of this specification or as shown on the drawings to form a continuous uniform support around the entire circumference of the pipe. The pipe shall be loaded sufficiently during backfilling around the sides and during compaction to prevent displacement of the pipe.

7. BACKFILL

a. Initial Backfill

Unless otherwise specified, initial backfill to six (6) inches above the top of the conduit is required. Earth haunching and initial backfill materials shall consist of soil material that is free of rocks, stones or hard clods greater than one (1) inch in diameter. Coarse backfill material shall be the specified sand, gravel, crushed rock or drainfill material.

Initial backfill shall be placed in two (2) stages. The first stage (haunching) backfill is placed to the pipe spring line (center of pipe). The second stage backfill is placed to six (6) inches above the top of the pipe. The first stage material shall be worked carefully under the haunches of the pipe to provide continuous support throughout the entire pipe length. The haunching backfill material shall be placed in layers approximately six (6) inches maximum thickness and compacted as specified in Section 14 of this specification or as shown on the drawings. During compaction operations, care shall be taken to ensure that the tamping or vibratory equipment does not come in contact with the pipe and the pipe is not deformed or displaced.

When pressure testing is not specified, the pipe shall be covered with a minimum of six (6) inches of backfill material as soon as possible following assembling of the pipe in the trench, but not later than within the same day that placement has occurred. When pressure testing is specified, sufficient backfill material shall be placed over the pipe to anchor the conduit against movement during pressure testing activities.

b. Final Backfill

Final backfill shall consist of placing the remaining material required to complete the backfill from the top of the initial backfill to the ground surface, including mounding at the top of the trench. Final backfill material within two (2) feet of the top of the pipe shall be free of debris or rocks larger than three (3) inches nominal diameter. Coarse backfill materials shall be the specified sand, gravel, crushed rock or drainfill. Final backfill shall be placed in approximately uniform, compacted layers. Final backfill compaction requirements shall be as specified in Section 14 of this specification or as shown on the drawings.

Vehicles or construction equipment shall not be allowed to cross the pipe until the minimum earth cover and required density as specified in Section 14 of this specification has been obtained.

8 PIPE ENCASEMENT IN CONCRETE

Concrete encasement shall be carefully placed to form a continuous uniform support around the entire circumference of the pipe as specified in Section 14 of this specification or as shown on the drawings. Pipes encased in concrete shall be securely anchored to prevent movement of the pipe during concrete placement. A clear distance of 1 1/2 inches shall be maintained between the pipe and the reinforcing steel.

The concrete for the encasement shall conform to the requirements of Construction Specification 32, Structure Concrete, for Class 3000M concrete, unless otherwise specified.

9. JOINTS

Unless otherwise specified in Section 14 of this specification or shown on the drawings, joints shall be either bell and spigot type with elastomeric gaskets, coupling type, solvent cement bell and spigot, or jointed by butt heat fusion. When a lubricant is required to facilitate joint assembly, it shall be a type having no deleterious affect on the gasket or pipe materials.

Pipe joints shall be watertight at the pressures specified except where unsealed joints are indicated.

Pipe shall be installed and joined in accordance with the manufacturer's recommendations. Laying deflections and joint fitting or stab depths shall be within the manufacturer's recommended tolerances.

When solvent cement joints are specified for PVC pipe and fittings, they shall be made in accordance with the following ASTMs and the related appendix of each ASTM; D 2855 for PVC pipe and fittings.

Flanged, banded, heat-fusion, or elastomeric-sealed mechanical joints shall be used when joining polyethylene (PE) and high density polyethylene (HDPE) pipe and fittings, unless otherwise specified in Section 14 of this specification or as shown on the drawings.

Pipe ends shall be cut square and be de-burred to provide uniform, smooth surfaces for the jointing process. Reference marks shall be placed on the spigot ends to assist in determining when proper seating depth has been achieved within the joint.

10. FITTINGS

Unless otherwise specified, steel fittings, valves, and bolted connections shall be painted or coated as recommended by the manufacturer.

Fittings for non-pressure pipe shall be of the same or similar materials as the pipe and shall provide the same durability, watertightness, and strength as the pipe, unless otherwise specified.

11. THRUST BLOCKS AND ANCHORS

When specified, concrete thrust blocks and anchors shall be installed as shown on the drawings or specified in Section 14 of this specification.

The concrete for the thrust blocks and anchors shall conform to the requirements of Construction Specification 32, Structure Concrete, for Class 3000M concrete, unless otherwise specified in Section 14 of this specification.

The thrust block cavity shall be hand dug into undisturbed soil or previously placed compacted backfill. The cavity shall be formed with soil or wood to hold the freshly place concrete without displacement until an initial set has occurred.

When excavation beyond the designated trench widths and depths as shown on the drawings or specified in Section 14 of this specification occurs at locations where installation of concrete thrust blocks is required, the Contractor shall install an alternative thrust block provision. The concrete thrust block shall have a thickness of one pipe diameter and a contact face area as shown on the drawings or specified in Section 14 of this specification which shall be formed against the pipe. Backfill shall be placed on all sides of the thrust block and to the sides of the excavation and compacted as specified for initial backfill.

12. PRESSURE TESTING

Pressure testing of the completed conduit is not required.

13. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the quantity of each kind, size, and class of pipe will be determined to the nearest foot by measurement of the laid length along the crown centerline of the conduit. Payment for each kind, size, and class of pipe will be made at the contract unit price for that kind, size, and class. Such payment will constitute full compensation for furnishing, transporting, and installing the pipe including excavation, shoring, backfill, bedding, thrust blocks, and all fittings, appurtenances, and all other items necessary and incidental to the completion of the work. Payment for appurtenances listed separately in the bid schedule will be made at the contract prices for those items.

Compensation for any items of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and items to which they are made subsidiary are identified in Section 14 of this specification.

14. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 14, PVC Plastic Pipe, 6" Diameter, Slotted

(1) This item shall consist of furnishing and installing the PVC plastic pipe and appurtenances for the foundation drain, diaphragm and impact basin drain as shown on the drawings.

(2) The PVC plastic pipe shall meet one of the following requirements.

(a) Pipe conforming to AWWA C-900 shall have minimum pressure class of 150 psi at 73.4 degrees F.

(b) Pipe conforming to ASTM D2441 shall be SDR 17 or heavier.

(c) Pipe conforming to ASTM D1785 shall be Schedule 80 or heavier.

(3) Pipe bedding or encasement shall be as shown on the drawings.

(4) Pipe joints shall be bell and spigot type with elastomeric gaskets.

(5) The 6-inch diameter slotted PVC plastic pipe adjacent to the impact basin includes 8 linear feet of non-slotted pipe.

(6) Slotted pipe shall have 10 square inches minimum open area per foot of length. The slots shall be 0.125 inch wide and uniformly spaced in 3 or more rows. The slots shall be circumferential, square cut, true, and free of burrs. The slots shall be cut in the specified pipe by a manufacturer normally engaged in the manufacture of well screens or casing and related products.

CONSTRUCTION SPECIFICATION

63. TREATMENT OF ROCK SURFACES

1. SCOPE

This work shall consist of preparing and cleaning the designated rock surfaces, including the specified dental excavation, and the furnishing and placing of the specified treatment material for either dental or slurry grout.

2. MATERIALS

Portland cement shall conform to the requirements of Material Specification 531 for the type specified in Section 10 of this specification.

Pozzolans. Unless otherwise specified in Section 10 of this specification, pozzolans conforming to the ASTM C 618, Class C or F, may be used in amounts not to exceed 25 percent, based on absolute volume, to substitute for an equal amount of portland cement in the concrete grout mixture.

Aggregates shall conform to the requirements of Material Specification 522, except that the grading for coarse aggregate shall be as specified in Section 10 of this specification.

Water shall be clean and free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.

Admixtures, when specified, shall be of the type and quality specified in Section 10 of this specification.

Curing compound shall conform to the requirements of Material Specification 534.

3. PREPARATION AND CLEANING

After excavation of the overburden has been completed, the rock surfaces shall be thoroughly cleaned and dewatered. All loose rock, ledges, and overhangs exposed during preparation of the rock surfaces shall be removed. Surfaces exceeding the slope limitations specified in Section 10 of this specification shall be eliminated by excavation or by filling with concrete as described in Section 7 of this specification.

Dental excavation shall consist of the removal of all soil and soft or loose rock from cracks, fissures, holes, and solution channels exposed during excavation activities. The extent of the dental excavation shall be as shown on the drawings with on-site adjustments as determined by the Engineer.

The surfaces shall be cleaned by air-water cutting, water jetting, wire brush scrubbing, or other suitable methods determined necessary to obtain an acceptable surface. No surface treatment material shall be applied until rock surfaces have been inspected and approved.

Rock surfaces shall be free of standing or running water during the placement of surface treatment material.

4. DESIGN OF SURFACE TREATMENT MATERIAL

The treatment material and mix proportions shall be as specified in Section 10 of this specification. During the surface treatment operation, the Engineer may require adjustment of the mix proportions. The mix shall not be altered without the approval of the Engineer.

5. HANDLING AND MEASUREMENT OF MATERIALS

Materials shall be stockpiled and batched by methods that will prevent segregation or contamination of aggregates and insure accurate measurement and proportioning of the mix ingredients.

Except as otherwise provided in Section 10 of this specification, cement and aggregates shall be measured as follows:

a. Cement shall be measured by weight or in bags of 94 pounds each. When cement is measured in bags, no fraction of a bag shall be used unless properly weighed.

b. Aggregates shall be measured by weight. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be required saturated, surface-dry weight plus the weight of the surface moisture it contains at the time of batching.

c. Water shall be measured, by volume or weight, to an accuracy within one (1) percent of the total quantity of water required for the batch.

d. Admixtures shall be measured within a limit of accuracy of three (3) percent.

6. MIXERS AND MIXING

The mixer, when operating at capacity, shall be capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and of discharging the mix with a satisfactory degree of uniformity.

The mixer shall be operated within the limits of the manufacturer's guaranteed capacity and speed of rotation.

The time of mixing, after all cement and aggregates are combined in the mixer, shall be a minimum of one (1) minute for mixers having a capacity of one (1) cubic yard or less. For larger capacity mixers, the minimum time shall be increased fifteen (15) seconds for each cubic yard or fraction thereof of additional capacity. The batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates, with the balance of the mixing water introduced into the mixer before one-fourth (1/4) of the total mixing time has elapsed.

No mixing water in excess of the amount required by the approved job mix shall be added to the grout mix during mixing or hauling or after arrival at the delivery point.

7. CONVEYING AND PLACING

Surface treatment materials shall be delivered to the site and placed within 1 1/2 hours after the introduction of the cement to the aggregates. In hot weather or under conditions contributing to accelerated stiffening of the concrete, the time between the introduction of the cement to the aggregates and complete discharge of the concrete shall be a maximum of 45 minutes. The Engineer may allow a longer period, provided the setting time of the concrete is increased a corresponding amount by the addition of an approved set-retarding admixture. In any case, concrete shall be conveyed from the mixer to the final placement as rapidly as practical by methods that will prevent segregation of the aggregates and/or loss of mortar.

Concrete shall not be allowed to free fall more than five (5) feet unless suitable equipment is used to prevent segregation.

Surface treatment materials shall not be placed until the rock surfaces have been inspected and approved by the Engineer.

All cracks, fissures, solution channels, and other surfaces within the designated area shall be treated as shown on pages 63-5 and 63-6. Surfaces to be treated shall be kept moist for a minimum of two (2) hours prior to treatment.

Concrete shall be filled against any specified remaining rock surfaces that exceed the slope limitations and shall be shaped so that no portion of the finished surface exceeds these limitations.

Material placed in cracks, fissures, and solution channels shall be consolidated by vibration, spading, or tamping as necessary to assure complete filling of the void.

8. CURING AND PROTECTION

Method 1 The surface of treatment materials shall be prevented from drying for a minimum curing period of seven (7) days after placement. Exposed surfaces shall be maintained in a moist condition continuously for the seven (7) day curing period, or until curing compound has been applied as specified in this section. Moisture shall be maintained by sprinkling, flooding or fog spraying or by covering with continuously moistened canvas, cloth mats, straw, sand or other acceptable material. Water or moist covering shall be utilized to protect the concrete treatment during the curing process without causing damage to the treatment surface by erosion or other mechanisms that may cause physical damage.

The concrete treatment material may be coated with an approved curing compound as an alternative method to maintaining a continuous moisture condition during the curing period. The compound shall be sprayed on the moist treatment surfaces as soon as free water has disappeared and all surface finishing has been completed. The compound shall be applied at a minimum uniform rate of one (1) gallon per 175-square feet of surface and shall form a continuous adherent membrane over the entire treated surface. Curing compound shall not be applied to surfaces requiring bond to subsequently placed grout and/or concrete. If the membrane is damaged during the curing period, the damaged area shall be re-sprayed at the rate application specified for the original treatment.

Backfilling operations shall not commence for a minimum period of 24 hours following the placement of concrete treatment, unless otherwise specified.

Method 2 A minimum earth cover of 1 1/2 feet depth shall be placed and compacted before the rock surface treatment material (concrete) has established an initial set. The earth cover may be placed on the concrete with a dragline, hoe, or else bladed onto the treated surface by lightweight dozer or similar equipment operating from a covered and compacted surface. Compaction shall be accomplished by pneumatic-tired equipment or by an alternative method that will provide an equivalent density.

Use With Either Method No backfill material shall be placed until the treated surfaces have been inspected and approved by the Engineer.

Surface treatment materials shall not be placed when the daily minimum temperature is less than 40° F unless facilities are provided to insure that the temperature of the materials is maintained at a minimum temperature of 50° F and not greater than 90° F during placement and the curing period. Concrete treatment material shall not be placed on frozen surfaces. When freezing conditions prevail, rock surfaces to be treated must be covered and heated to within a range of 50° F and 90° F for a minimum period of 24 hours prior to placing concrete treatment materials.

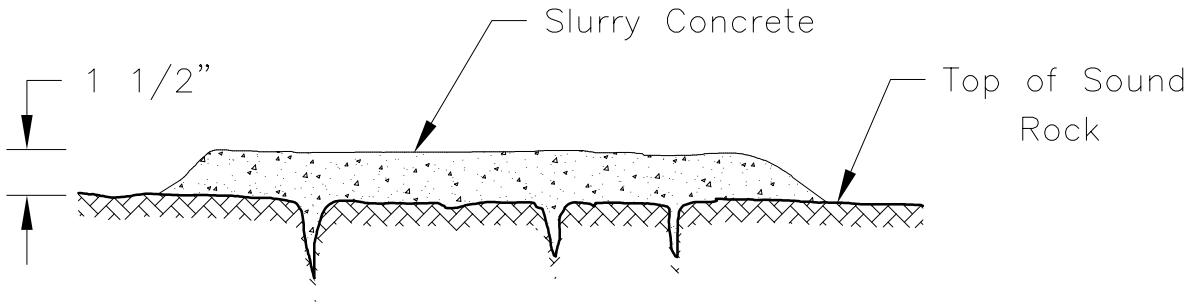
9. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the area of rock surfaces to be prepared, cleaned and treated will not be measured. The volume of surface treatment materials delivered and properly installed to treat rock surfaces will be determined to the nearest 0.1 cubic yard. Areas to be treated are shown on the drawings with the final extent of rock surface treatment to be determined by the Engineer. The volume of any waste or otherwise unsuitable material will be determined by procedures established by the Engineer and deducted from the volume of concrete delivered to the site. Payment will be made at the contract unit price for surface preparation, cleaning, and installation of surface treatment materials. Such payment shall constitute full compensation of all labor, equipment, materials and all other items necessary and incidental to the completion of the work.

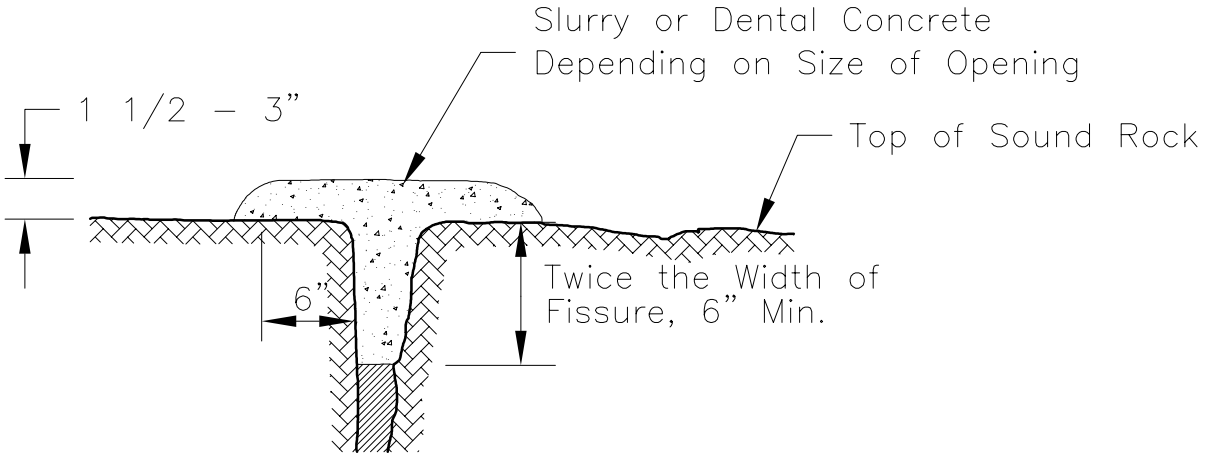
For each load of concrete delivered to the site for placement as rock treatment material, the Contractor shall furnish to the Engineer a delivery ticket at the time of delivery which shall provide as a minimum: Weights in pounds of cement, aggregates (fine and coarse), pozzolan (if used), water; weight in ounces of air-entraining agent; time of loading; and, the revolution counter reading at the time batching was started.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 10 of this specification.

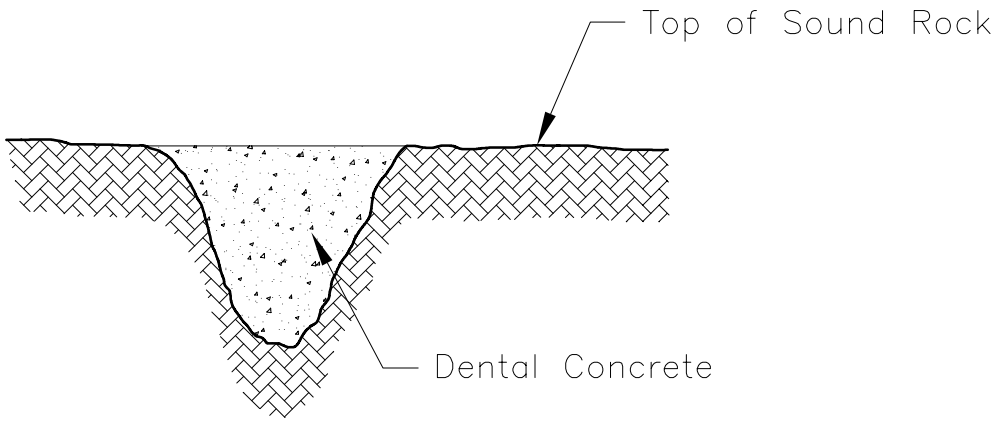
TYPICAL TREATMENTS OF ROCK SURFACES



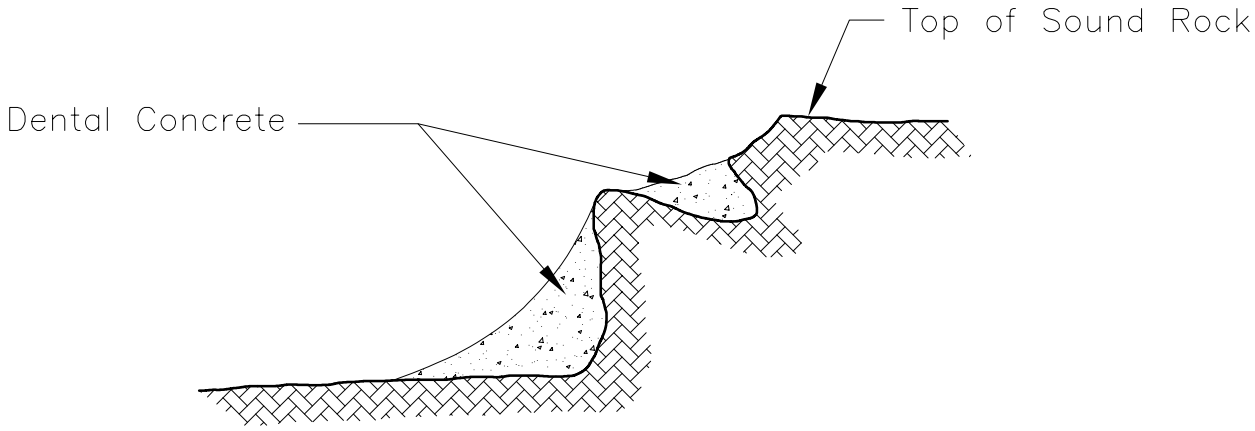
1) THIN SURFACE CRACKS



2) OPEN FISSURES



3) HOLES OR SOLUTION CHANNELS



4) OVERHANGS AND IRREGULAR SURFACES

10. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Subsidiary Item, Treatment of Rock Surfaces

(1) This item shall consist of preparing rock surfaces encountered in the core trench for treatment.

(2) Concrete shall conform to and be paid for as shown in Construction Specification 31.

(3) Surfaces exhibiting vertical or overhanging slopes shall be eliminated by excavation or by filling with concrete as described in Section 7 of this specification.

(4) Curing and protection shall be by Method 2.

(5) No separate payment will be made for this item. Compensation for this item shall be included in the payment for Concrete or Common Excavation as appropriate.

CONSTRUCTION SPECIFICATION

81. METAL FABRICATION AND INSTALLATION

1. SCOPE

The work shall consist of furnishing, fabricating and erecting metalwork, including the metal parts and fasteners of the composite structures.

2. MATERIALS

Unless otherwise specified, materials shall conform to the requirements of Material Specification 581, Metal. Steel shall be structural quality unless otherwise specified. Castings shall be thoroughly cleaned and subjected to careful inspection before installation. Finished surfaces shall be smooth and true to assure proper fit. Galvanizing shall conform to the requirements of Material Specification 582, Galvanizing.

3. FABRICATION

Fabrication of structural steel shall conform to the requirements of "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings (Riveted, Bolted and Arc-Welded Construction)," American Institute of Steel Construction.

Fabrication of structural aluminum shall conform to the requirements in the 'Aluminum Design Manual' available from The Aluminum Association.

4. ERECTION

The frame of metal structures shall be installed true and plumb. Temporary bracing shall be placed wherever necessary to resist all loads to which the structure may be subjected, including those applied by the installation and operation of equipment. Such bracing shall be left in place as long as may be necessary for safety.

As erection progresses the work shall be securely bolted up, or welded, to resist all dead load, wind and erection stresses. The Contractor shall furnish such installation assisting bolts, nuts and washers as may be required.

No riveting or welding shall be performed until the structure is stiffened and properly aligned.

Rivets driven in the field shall be heated and driven with the same care as those driven in the shop.

All field welding shall be performed in conformance to the requirements for shop fabrication, except those that expressly apply to shop conditions only.

5. PROTECTIVE COATINGS

Items specified to be galvanized shall be completely fabricated for field assembly before the application of the zinc coatings. Galvanized items shall not be cut, welded or drilled after the zinc coating is applied.

Items specified to be painted shall be painted in conformance to the requirements of Construction Specification 82 for the specified paint systems.

6. MEASUREMENT AND PAYMENT

The work will not be measured. Payment for metal fabrication and installation will be made at the contract lump sum price in the contract. Such payment will constitute full compensation for all labor, equipment, materials and all other items necessary and incidental to the completion of the work, including connectors and appurtenances such as rivets, bolts, nuts, pins, studs, washers, hangers and weld metal.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

7. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 16, Aluminum Trash Racks and Grating

(1) This item shall consist of furnishing, fabricating, and installing the aluminum trash racks for the concrete riser, the concrete drawdown inlet, and the grating for the impact basin as shown on the drawings.

CONSTRUCTION SPECIFICATION

91. CHAIN LINK FENCE

1. SCOPE

The work shall consist of furnishing and installing chain link fencing complete with all posts, braces, gates and all other appurtenances.

2. MATERIALS

The materials for the chain link fence shall be as follows:

Galvanized

Chain link fence fabric shall conform to the requirements of ASTM A 392, 2-inch mesh, and 9-gauge galvanized steel wire. Zinc coating shall be Class 2.

Posts and fence framework shall conform to the requirements of ASTM F 1043 Group 1A, for Heavy Industrial Fence. Coatings shall be a Type A galvanized coating for both internal and external surfaces. Steel pipe posts shall conform to the requirements of ASTM F 1043 and F 1083.

Fence fittings shall conform to the requirements of ASTM F 626. Fittings shall be galvanized steel. Wire ties and clips shall be 9-gage.

Gates, gate posts and gate accessories shall conform to the requirements of ASTM F 900. Coating shall be the same as selected for adjoining fence and framework.

Barbed wire shall be 12 1/2 gage and shall conform to the requirements of ASTM A 121, chain link fence grade.

Galvanized and PVC Coated

Chain link fence fabric shall conform to the requirements of ASTM F 668 for Class 2a or 2b, 2-inch mesh, and 9-gauge galvanized steel wire. The fabric shall have a polymer top coating of the color specified in Section 6.

Posts and fence framework shall conform to the requirements of ASTM F 1043 Group 1A, for Heavy Industrial Fence. Coatings shall be a Type A galvanized coating for both internal and external surfaces and covered with a polymer top coating of color as specified in Section 6.

Fence fittings shall conform to the requirements of ASTM F 626. Fittings shall be galvanized steel with a polymer top coating of color as specified in Section 6.

Any damage to the coating shall be repaired in accordance with the manufacturer's recommendations or the damaged fencing material shall be replaced. The Contractor shall provide the Engineer a copy of the manufacturer's recommended repair procedure and materials prior to correcting damaged coatings.

3. INSTALLING FENCE POSTS

Unless otherwise specified, line posts shall be placed at intervals of ten (10) feet measured from center to center of adjacent posts. In determining the post spacing, measurement will be made parallel with the ground surface.

Posts shall be set in concrete backfill in the manner shown on the drawings.

Posts set in the tops of concrete walls shall be grouted into preformed holes to a depth of 12-inches.

All corner posts, end posts, gate posts, and pull posts shall be embedded, braced and trussed as shown on the drawings or in accordance with appropriate industry practice if not otherwise shown or specified.

4. INSTALLING WIRE FABRIC

Fencing fabric shall not be stretched until at least four (4) days after the posts are grouted into walls or seven (7) days after the posts are set in the concrete backfill.

Fencing fabric shall be installed on the side of the posts designated on the drawings.

The fabric shall be stretched taut and securely fastened, by means of tie clips, to the posts at intervals not exceeding 15-inches and to the top rails or tension wires at intervals not exceeding two (2) feet. Care shall be taken to equalize the fabric tension on each side of each post.

Barbed wire shall be installed as shown on the drawings and shall be pulled taut and fastened to each post or arm with the tie wires or metal tie clips.

5. MEASUREMENT AND PAYMENT

Method 1: The length of fence will be measured to the nearest 0.1 foot along the fence, including gates. Payment will be made at the contract unit price for the specified height of fence. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work.

Method 2: The length of fence will be measured to the nearest 0.1 foot along the fence, excluding gate openings. Payment will be made at the contract unit price for the specified height of fence. The number of each size and type of gate installed will be determined. Payment will be made at the contract unit price for that type and size of gate. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work.

All Methods: The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 6 of this specification.

6. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 18, Fence – Chain Link

(1) This item shall consist of furnishing and installing the chain link fence around the impact basin.

(2) Materials for the fence fabric, corner posts, end posts, line posts and top rails shall be black polyvinyl chloride (PVC) coating bonded to aluminum coated steel. PVC coating shall be 0.01 inch thick unless otherwise specified.

(3) The fence fabric shall be constructed of 9 gage wire 72 inches high.

(4) Corner posts and end posts shall be pipes with a minimum outside diameter of 2.875 inches and a minimum weight of 5.8 pounds per foot.

(5) Line posts shall be pipes with a minimum outside diameter of 2.375 inches and a minimum weight of 3.6 pounds per foot.

(6) Top rails shall be pipes with a minimum outside diameter of 1.9 inches and a minimum weight of 2.7 pounds per foot.

(7) The fencing shall include post tops, rail ends, fabric bands and other fittings necessary to install the fence. Tops and rail ends shall fit over the pipe. Fittings shall be PVC coated to thickness of standard industry practices.

(8) The fabric shall be placed on the outside of the posts.

(9) Tie wires shall be minimum 9 gage aluminum or 11 gage galvanized steel

(10) No braces, trusses, tension wires, etc., will be used at corner posts and terminal posts.

(11) Included in installation of the fence is filling post holes with concrete. The concrete shall consist of 1 part cement, 2 parts sand, and 3 parts gravel unless otherwise approved. Sufficient water will be added to obtain slump between 3 to 5 inches. The concrete will be placed immediately after mixing.

(12) Measurement and payment will be by Method 1.

CONSTRUCTION SPECIFICATION

94. CONTRACTOR QUALITY CONTROL

1. SCOPE

The work shall consist of developing, implementing, and maintaining a quality control system to ensure that the specified quality is achieved for all materials and work performed.

2. EQUIPMENT AND MATERIALS

Equipment and materials used for quality control shall be of the quality and condition required to meet the test specifications cited in the contract. Testing equipment shall be properly adjusted and calibrated at the start of operations and the calibration maintained at the frequency specified. Records of equipment calibration tests shall be available to the Engineer at all times. Equipment shall be operated and maintained by qualified operators, as prescribed in the manufacturer's operating instructions, the references specified and as specified in Section 10 of this specification. All equipment and materials used in performing quality control testing shall be as prescribed by the test standards referenced in the contract or in Section 10.

All equipment and materials shall be handled and operated in a safe and proper manner and shall comply with all applicable regulations pertaining to their use, operation, handling, storage, and transportation.

3. QUALITY CONTROL SYSTEM

Method 1: The Contractor shall develop, implement and maintain a system of quality control to provide the specified material testing and verification of material quality prior to use. The system activities shall include procedures to verify adequacy of completed work, initiate corrective action to be taken and document the final results. The identification of the quality control personnel and their duties and authorities shall be submitted to the Contracting Officer in writing within 15 calendar days after notice of award.

Method 2 The Contractor shall develop, implement and maintain a system adequate to achieve the specified quality of all work performed, material incorporated and equipment furnished prior to use. The system established shall be documented in a written plan developed by the Contractor and approved by the Contracting Officer. The system activities shall include the material testing and inspection needed to verify the adequacy of completed work and procedures to be followed when corrective action is required. Daily records to substantiate the conduct of the system shall be maintained by the Contractor. The quality control plan shall cover all aspects of quality control and shall address, as a minimum, all specified testing and inspection requirements. The plan provided shall be consistent with the planned performance in the Contractor's approved construction schedule. The plan shall identify the Contractor's on-site quality control manager and provide an organizational listing of all quality control personnel and their specific duties. The written plan shall be submitted to the Contracting Officer within 15 calendar days after notice of award. The Contractor shall not proceed with any construction activity, which requires inspection until the written plan is approved by the Contracting Officer.

All Methods The quality control system shall include, but not be limited to, a rigorous examination of construction materials, processes and operation, including testing of

materials and examination of manufacturer's certifications as required, to verify that work meets contract requirements and is performed in a competent manner.

4. QUALITY CONTROL PERSONNEL

Method 1 Quality control activities shall be accomplished by competent personnel. A competent person is: one who is experienced and capable of identifying, evaluating, and documenting that materials and processes being used will result in work that complies with the contract; and, who has authority to take prompt action to remove, replace, or correct such work or products not in compliance. Off-site testing laboratories shall be certified or inspected by a nationally recognized entity. The Contractor shall submit to the Contracting Officer, for approval, the names, qualifications, authorities, certifications, and availability of the competent personnel who will perform the quality control activities.

Method 2: Quality control activities shall be accomplished by competent personnel who are separate and apart from line supervision and who report directly to management. A competent person is: one who is experienced and capable of identifying, evaluating, and documenting that materials and processes being used will result in work that complies with the contract; and, who has authorization to take prompt action to remove, replace, or correct such work or products not in compliance. Off-site testing laboratories shall be certified or inspected by a nationally recognized entity. The Contractor shall submit to the Contracting Officer, for approval, the names, qualifications, authorities, certifications, and availability of the competent personnel who will perform the quality control activities.

5. POST-AWARD CONFERENCE

The Contractor shall meet with the Contracting Officer prior to the beginning of any work and discuss the Contractor's quality control system. The Contracting Officer and the Contractor shall develop a mutual understanding regarding the quality control system.

6 RECORDS

The Contractor's quality control records shall document both acceptable and deficient features of the work and corrective actions taken. All records shall be:

a. On forms approved by the Contracting Officer,

b. Legible, and

c. Dated and signed by the competent person creating the record.

Unless otherwise specified in Section 10 of this specification, records shall include:

a. Documentation of shop drawings including date submitted to and date approved by the Contracting Officer, results of examinations, any need for changes or modifications, manufacturer's recommendations and certifications, if any, and signature of the authorized examiner.

b. Documentation of material delivered including quantity, storage location, and results of quality control examinations and tests.

c. Type, number, date, time, and name of individual performing of quality control activities.

d. The material or item inspected and tested; the location and extent of such material or item; a description of conditions observed; and test results obtained during the quality control activity.

e. The determination that the material or item met the contract provisions and documentation that the Engineer was notified.

f. For deficient work the nature of the defects, specifications not met, etc., corrective action taken and results of quality control activities on the corrected material or item.

7. REPORTING RESULTS

The results of Contractor quality control inspections and tests shall be communicated to the Engineer immediately upon completion of the inspection or test. Unless otherwise specified in Section 10, the original plus one copy of all records, inspections, tests performed and material testing reports shall be submitted to the Engineer within one working day of completion. The original plus one copy of documentation of materials delivered shall be submitted to the Engineer prior to the use of the material.

8. ACCESS

The Contracting Officer and the Engineer shall be given free access to all testing equipment, facilities, sites, and related records for the duration of the contract.

9. PAYMENT

Method 1: For items of work for which lump sum prices are established in the contract, payment will be made as the work proceeds, after presentation by the Contractor of invoices showing related costs and evidence of charges by suppliers, subcontractors, and others for furnishing supplies and work performed. If the total of such payments is less than the lump sum contract price for this item, the remaining balance will be included in the final contract payment. Payment of the lump sum contract price will constitute full compensation for completion of the work.

Payment will not be made under this item for the purchase cost of materials and equipment having a residual value.

Method 2: For items of work for which lump sum prices are established in the contract, payment will be prorated and paid in equal amounts on each monthly estimate. The number of months used for prorating shall be the number estimated to complete the work. The final month's prorate amount will be made with the final payment. Payment as described above will constitute full compensation for completion of the work.

Payment will not be made under this item for the purchase cost of materials and equipment having a residual value.

All Methods: Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 10.

10. ITEM OF WORK AND CONSTRUCTION DETAILS

The Contractor shall designate an experienced quality control manager who will be implementing the inspection system. The manager shall be on site during major construction activities as needed to achieve the specified quality for the work being performed.

The names and qualifications of proposed quality control personnel shall be submitted to the Contracting Officer for review and approval prior to the pre-construction conference. Any change of quality control personnel will require the approval of the Contracting Officer.

Testing equipment shall be calibrated after it is delivered to the site and whenever erratic or unreasonable test results are being obtained.

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 4, Contractor Quality Control

(1) This item shall consist of furnishing the personnel, equipment and materials required by the Contractor to perform the inspection and testing necessary to implement an inspection system that will ensure the specified quality is being maintained. Method 2 shall be used for Quality Control System and Quality Control Personnel. Sections (2), (3), and (4) below must be performed and reported as an additional part of the inspection system.

(2) Concrete Testing:

(a) The quality control for concrete shall include the sampling and testing of fresh concrete for the purpose of determining air content, temperature, slump, and the molding of compression test cylinders. All testing and sampling shall be in accordance with Construction Specification 31, Section 4.

(b) As a minimum, one set (4 test cylinders) of compression strength cylinders shall be obtained for each Class 4,000 concrete placement in the riser and impact basin and one set for the conduit bedding. For each set of 4 test cylinders, one shall be tested at 7 days and the remaining three at 28 days.

(c) Concrete cylinders shall be transported in accordance with ASTM C31 from the job site to the testing lab.

(d) As a minimum, the concrete from each truckload delivered to the site shall be tested for air content, temperature, and slump. These tests shall be performed from concrete sampled at the beginning of the load.

(e) A separate air content and slump test shall be performed from the concrete sample used to cast the compression cylinders.

(f) If cold or hot weather concrete, as defined in Construction Specification 31, is anticipated or encountered, a separate inspection plan for cold or hot weather concreting is required.

(3) Concrete Aggregate, Drainfill, and Rock Riprap Testing:

Testing shall be performed to ensure proper gradation and conformance to the appropriate Material Specification. Contractor shall give the Government three (3) days advance notice of collecting test samples so that the Government may attend and observe.

(4) Earthfill testing:

Class A earthfill shall be tested in compliance with the following standard:

Standard Proctor	ASTM D-698, Method A, B, or C

Testing will be performed on material from each type of earthfill material.

Moisture density tests are to be performed at the following minimum rates:

(a) Two per day in the foundation.

(b) One per day in embankment.

(c) One test for each 4,000 cubic yards of earthfill.

(5) Measurement and Payment shall be by Method 1.

CONSTRUCTION SPECIFICATION

95. GEOTEXTILE

1. SCOPE

This work shall consist of furnishing all materials, equipment, and labor necessary for the installation of geotextiles.

2. QUALITY

Geotextiles shall conform to the requirements of Material Specification 592 and this specification.

3. STORAGE

Prior to use, the geotextile shall be stored in a clean dry location, out of direct sunlight, not subject to extremes of either hot or cold temperatures, and with the manufacturer's protective cover undisturbed. Receiving, storage, and handling at the job site shall be in accordance with the requirements listed in ASTM D 4873.

4. SURFACE PREPARATION

The surface on which the geotextile is to be placed shall be graded to the neat lines and grades as shown on the drawings. The surface shall be reasonably smooth and free of loose rock and clods, holes, depressions, projections, muddy conditions and standing or flowing water (unless otherwise specified in Section 7 of this specification).

5. PLACEMENT

Prior to placement of the geotextile, the soils surface will be reviewed for quality assurance of the design and construction. The geotextile shall be placed on the approved prepared surface at the locations and in accordance with the details shown on the drawings and specified in Section 7 of this specification. The geotextile shall be unrolled along the placement area and loosely laid, without stretching, in such a manner that it will conform to the surface irregularities when material or gabions are placed on or against it. The geotextile may be folded and overlapped to permit proper placement in designated area(s).

Method 1 The geotextile shall be joined by machine sewing using thread material meeting the chemical requirements for the geotextile fibers or yarn. The sewn overlap shall be six (6) inches and the sewing shall consist of two (2) parallel stitched rows at a spacing of approximately one (1) inch and shall not cross (except for any required re-stitching). The stitching shall be a lock-type stitch. Each row of stitching shall be located a minimum of two (2) inches from the geotextile edge. The seam type and sewing machine to be used shall produce a seam strength, in the specified geotextile, that provides a minimum of 90-percent of the tensile strength in the weakest principal direction of the geotextile being used, when tested in accordance with ASTM D 4884. The seams may be factory or field sewn.

The geotextile shall be temporarily secured during placement of overlying materials to prevent slippage, folding, wrinkling, or other displacement of the geotextile. Unless otherwise specified, methods of securing shall not cause punctures, tears or other openings to be formed in the geotextile.

Method 2 The geotextile shall be joined by overlapping a minimum of 18 inches (unless otherwise specified), and secured against the underlying foundation material. Securing pins, approved and provided by the geotextile manufacturer, shall be placed along the edge of the panel or roll material to adequately hold it in place during installation. Pins shall be steel or fiberglass formed as a "U", "L", or "T" shape or contain "ears" to prevent total penetration through the geotextile. Steel washers shall be provided on all but the "U" shaped pins. The upstream or up-slope geotextile shall overlap the abutting down-slope geotextile. At vertical laps, securing pins shall be inserted through the bottom layers along a line through approximately the mid-point of the overlap. At horizontal laps and across slope labs, securing shall be inserted through the bottom layer only. Securing pins shall be placed along a line approximately two (2) inches in from the edge of the placed geotextile at intervals not to exceed 12 feet unless otherwise specified. Additional pins shall be installed as necessary and where appropriate, to prevent any undue slippage or movement of the geotextile. The use of securing pins will be held to the minimum necessary. Pins are to remain in-place unless otherwise specified.

Should the geotextile be torn or punctured, or the overlaps or sewn joint disturbed, as evidenced by visible geotextile damage, subgrade pumping, intrusion, or grade distortion, the backfill around the damaged or displaced area shall be removed and restored to the original approved condition. The repair shall consist of a patch of the same type of geotextile being used and overlaying the existing geotextile. When the geotextile seams are required to be sewn, the overlay patch shall extend a minimum of one (1) foot beyond the edge of any damaged area and joined by sewing as required for the original geotextile except that the sewing shall be a minimum of six (6) inches from the edge of the damaged geotextile. Geotextile panels joined by overlap shall have the patch extend a minimum of two (2) feet from the edge of any damaged area.

Geotextile shall be placed in accordance with the following applicable specification according to the use indicated in Section 7:

a. Slope Protection The geotextile shall not be placed until it can be anchored and protected with the specified covering within 48 hours or protected from exposure to ultraviolet light. In no case shall material be dropped on uncovered geotextile from a height greater than three (3) feet.

b. Subsurface Drains The geotextile shall not be placed until drainfill or other material can be used to provide cover within the same working day. Drainfill material shall be placed in a manner that prevents damage to the geotextile. In no case shall material be dropped on uncovered geotextile from a height greater than five (5) feet.

c. Road Stabilization The geotextile shall be unrolled in a direction parallel to the roadway centerline in a loose manner permitting conformation to the surface irregularities when the roadway fill material is placed on its surface. In no case shall material be dropped on uncovered geotextile from a height greater than five (5) feet. Unless otherwise specified, the minimum overlap of

geotextile panels joined without sewing shall be 24 inches. The geotextile may be temporarily secured with pins recommended or provided by the manufacturer, but they shall be removed prior to placement of the permanent covering material.

6. MEASUREMENT AND PAYMENT

Method 1 For items of work for which specific unit prices are established in the contract, the quantity of geotextile for each type placed within the specified limits will be determined to the nearest specified unit by measurements of the covered surfaces only, disregarding that required for anchorage, seams, and overlaps. Payment will be made at the contract unit price. Such payment will constitute full compensation for the completion of the work.

Method 2 For items of work for which specific unit prices are established in the contract, the quantity of geotextile for each type placed with the specified limits will be determined to the nearest specified unit by computing the area of the actual roll size, or partial roll size installed. The computed area will include the amount required for overlap, seams, and anchorage as specified. Payment will be made at the contract unit price. Such payment will constitute full compensation for the completion of the work.

Method 3 For items of work for which specific lump sum prices are established in the contract, the quantity of geotextile will not be measured for payment. Payment for geotextiles will be made at the contract lump sum price and will constitute full compensation for the completion of the work.

All Methods The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

7. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Subsidiary Item, Geotextile, Rock Gutters

(1) This item shall consist of furnishing and installing the geotextile beneath the rock riprap in the rock gutters as shown on the drawings.

(2) The geotextile fabric shall be non-woven, Class II, and conform to requirements in Table 2, Material Specification 592. Fabric weight shall be a minimum of 14 ounces per square yard.

(3) Placement of rock shall be accomplished by equipment capable of controlling the drop. The maximum drop is three feet. Rock shall not be pushed or rolled over the geotextile.

(4) The length of the geotextile shall extend parallel to the rock gutters in the direction of water flow.

(5) The geotextile shall be anchored in a header trench as shown on the drawings. The backfill shall be manually tamped earth.

(6) An erosion stop consisting of a 2 foot wide strip of geotextile shall be installed at approximately 100 foot intervals. The backfill shall be manually tamped earth.

(7) The width of the geotextile shall be overlapped a minimum of 18 inches and anchored with securing pins as specified by Method 2.

(8) The uphill roll shall overlap the downhill roll at least 24 inches.

(9) No separate payment will be made for this item. Compensation shall be included in the payment for Rock Riprap.

CONSTRUCTION SPECIFICATION

212. ROCK RIPRAP

1. SCOPE

The work shall consist of the construction of rock riprap revetments and blankets, including filter or bedding where specified.

2. MATERIALS

Rock riprap shall conform to the requirements of Material Specification 300C, 3OOD, or 300E as specified in Section 8 or, if so specified shall be obtained from designated sources. It shall be free from dirt, clay, sand, rock fines and other materials not meeting the required gradation limits.

At least 30 days prior to delivery of rock from other than designated sources, the Contractor shall designate in writing the source from which he intends to obtain the rock and information satisfactory to the Contracting Officer that the material meets the requirements of the contract. The Contractor shall provide the Engineer free access to the source for the purpose of obtaining samples for testing. The size and grading of the rock shall be as specified in Section 8.

Rock from designated sources shall be excavated, selected and processed as necessary to meet the quality and grading requirements in Section 8. The installed rock riprap shall conform to the specified grading limits.

Filter or bedding aggregates when required, shall, unless otherwise specified, conform to the requirements of Material Specification 521.

3. SUBGRADE PREPARATION

The subgrade surfaces on which the rock riprap, filter or bedding is to be placed shall be cut or filled and graded to the lines and grades shown on the drawings. When fill to subgrade lines is required, it shall consist of approved materials and shall conform to the requirements of the specified class of fill.

Rock riprap, filter or bedding shall not be placed until the foundation preparation is completed and the subgrade surfaces have been inspected and approved by the Engineer.

4. EQUIPMENT-PLACED ROCK RIPRAP

The rock riprap shall be placed by equipment on the surfaces and to the depths specified. The rock riprap shall be constructed to the full course thickness in one operation and in such a manner as to avoid serious displacement of the underlying materials. The rock riprap shall be delivered and placed in a manner that will insure that the riprap in place shall be reasonably homogeneous with the larger rocks uniformly distributed and firmly in contact one to another with the smaller rocks and spalls filling the voids between the larger rocks.

Rock riprap shall be placed in a manner to prevent damage to structures. Hand placing will be required to the extent necessary to prevent damage to the permanent works.

5. HAND-PLACED ROCK RIPRAP

The rock riprap shall be placed by hand on the surfaces and to the depths specified. It shall be securely bedded with the larger rocks firmly in contact one to another. Spaces between the larger rocks shall be filled with smaller rocks and spalls. Smaller rocks shall not be grouped as a substitute for larger rock. Flat slab rock shall be laid on edge.

6. FILTER OR BEDDING

When the contract specifies filter or bedding beneath riprap, the filter or bedding shall be placed on the prepared subgrade surfaces as specified. Compaction of filter or bedding aggregate will not be required, but the surface of such material shall be finished reasonably free of mounds, dips or windrows.

7. MEASUREMENT AND PAYMENT

Method 1 For items of work for which specific unit prices are established in the contract, the quantity of each type of rock riprap placed within the specified limits will be measured to the nearest ton by actual weight. The volume of each type of filter or bedding aggregate will be measured within the specified limits and computed to the nearest cubic yard by the method of average cross-sectional end areas. For each load of rock riprap placed as specified, the Contractor shall furnish to the Engineer a statement-of-delivery ticket showing the weight, to the nearest 0.1 ton.

Payment will be made at the contract unit price for each type of rock riprap, filter or bedding. Such payment will be considered full compensation for completion of the work.

Method 2 For items of work for which specific unit prices are established in the contract, the quantity of each type of rock riprap placed within the specified limits will be measured to the nearest ton by actual weight. The volume of each type of filter or bedding aggregate delivered and placed within the specified limits will be measured to the nearest cubic yard by measurement of the hauling equipment. For each load of rock riprap placed as specified, the Contractor shall furnish to the Engineer a statement-of-delivery ticket showing the weight, to the nearest 0.1 ton. For each load of filter or bedding aggregate the Contractor shall furnish to the Engineer the volume, to the nearest 0.1 cubic yard.

Payment will be made at the contract unit price for each type of rock riprap, filter or bedding. Such payment will be considered full compensation for completion of the work.

Method 3 For items of work for which specific unit prices are established in the contract, the volume of each type of rock riprap and filter or bedding aggregate will be measured within the specified limits and computed to the nearest cubic yard by the method of average cross-sectional end areas.

Payment will be made at the contract unit price for each type of rock riprap, filter or bedding. Such payment will be considered full compensation completion of the work.

Method 4 For items of work for which specific unit prices are established in the contract, the volume of each type of rock riprap, including filter and bedding, will be measured within the specified limits and computed to the nearest cubic yard by the method of average cross-sectional end areas.

Payment will be made at the contract unit price for each type of rock riprap, including filter and bedding. Such payment will be considered full compensation for completion of the work.

Method 5 For items of work for which specific unit prices are established in the contract, the quantity of each type of rock riprap placed within the specified limits will be measured to the nearest ton by actual weight. For each load of rock riprap placed as specified, the Contractor shall furnish to the Engineer a statement-of-delivery ticket showing the weight, to the nearest 0.1 ton.

Payment will be made at the contract unit price for each type of rock riprap. Such payment will be considered full compensation for completion of the work.

Method 6 For items of work for which specific unit prices are established in the contract, the volume of each type of rock riprap will be measured within the specified limits and computed to the nearest cubic yard by the method of average cross-sectional end areas.

Payment will be made at the contract unit price for each type of rock riprap. Such payment will be considered full compensation completion of the work.

All Methods The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 8.

8. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 15, Rock Riprap, Equipment Placed

(1) This item shall consist of furnishing and placing rock riprap in the outlet channel, around the impact basin and in the rock gutters as shown on the drawings.

(2) Rock riprap shall conform to Material Specification 300C. In accordance with Material Specification 300C, The Rock Slab Soundness Test (d) may be substituted in lieu of Soundness Test (c).

(3) The rock shall be equipment placed.

(4) The rock riprap material shall be reasonably well graded with 50 percent being 12 inches or larger and a maximum size of 16 inches. Sand and rock dust shall be less than 5%.

(5) Measurement and payment shall be by Method 4.

(6) A tolerance of plus 6 inches or minus 3 inches from the grades indicated will be allowed in the finished surface of the riprap, except that the extreme minimum tolerance shall not be continuous over an area exceeding 200 square feet.

(7) The bedding, where specified, shall be sound, durable material reasonably well graded, with maximum size of 3 inches and a minimum size of No. 40 sieve. Conformance to Material Specification 300C is not required.

(8) Items of work subsidiary to this bid item are:

(a) Miscellaneous Excavation – Construction Specification 21.

(b) Geotextile – Construction Specification 95.

CONSTRUCTION SPECIFICATION

702. TEMPORARY COVER - MULCH

1. SCOPE

The work shall consist of furnishing all labor, equipment and materials for mulching the areas as designated by the Engineer. The limits of the areas will be marked on the ground.

2. MATERIALS

Mulch shall be small grain straw or grass hay. The mulch shall be relatively free of weed seed.

3. APPLICATION

The mulch shall be applied uniformly over the designated area at a rate of two tons per acre. Anchor mulch with: (1) mulch tacker into the top one (1) inch of soil, or (2) wood cellulose fibertack or a water dispersible mulch tacker following manufacturer's recommendations. Insofar as practical all operations shall be performed on the contour.

4. MEASUREMENT AND PAYMENT

The mulch shall be measured to the nearest 0.1 ton. The contractor shall furnish evidence satisfactory to the engineer of the actual weight of mulch used. Payment for mulching will be made at the contract unit. Such payment shall constitute full compensation for all materials, labor, equipment and all other items necessary and incidental to completion of the work.

5. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 20, Temporary Cover - Mulch

(1) This item shall consist of all work and materials necessary to mulch the designated areas as needed to control pollution.

CONSTRUCTION SPECIFICATION

703. TEMPORARY SEEDING

1. SCOPE

The work shall consist of furnishing all labor, equipment and materials for seeding a temporary cover on the areas subject to erosion. The limits of the areas will be marked on the ground.

2. SEED AND DATES OF PLANTING

From March 1 to September 30, the seed shall be combine run spring oats. From October 1 to February 28, the seed shall be combine run rye.

3. SEED BED PREPARATION

A proper seed bed (2 to 3 inches deep) shall be prepared. The seed shall be sown or planted at a rate of two bushels per acre. The seed shall be lightly covered with soil material. Insofar as practical all operations shall be performed on the contour.

4. MEASUREMENT AND PAYMENT

The area seeded will be measured to the nearest 0.1 acre. Payment for seeding will be made at the contract unit price for the actual acres seeded. Such payment shall constitute full compensation for all materials, labor, equipment and all other items necessary and incidental to completion of the work.

5. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 21, Temporary Seeding

(1) This item shall consist of all work and materials necessary to seed the designated areas as needed to control pollution.

CONSTRUCTION SPECIFICATION

716. SILT FENCE

1. SCOPE

The work shall consist of furnishing, installing, maintaining and removing a geotextile barrier-fence designed to remove suspended particles from water passing through the fence, as shown on the drawings.

2. MATERIALS

Synthetic filter fabric shall be a pervious sheet of propylene, nylon, polyester or ethylene yarn and shall be certified by the manufacturer or supplier as conforming to the following requirements:

PHYSICAL PROPERTY	REQUIREMENTS[1]
Filtering Efficiency (ASTM D-5141)	75% (min.)
Mullen Burst Strength (ASTM D-3786)	200 psi
Grab Tensile Strength (ASTM D-4632)	100 lbs.
Flow Rate (ASTM D-5141)	0.3 gal/ft.^{3}/min.

[1] All numerical values represent minimum average roll values.

Product properties as listed in the current annual "Specifiers Guide", Geotechnical Fabrics Report, Industrial Fabrics Association International, 345 Cedar Street, Suite 450, St. Paul, Minnesota 55101; and that represents average minimum roll values, will be acceptable documentation that the product style meets the requirements of these specifications.

For products that do not appear in the above directory, or do not have minimum average roll values listed, typical test data from the identified production run of the geotextile will be required for each of the specified tests as covered under clause AGAR 452.236-76.

The geotextile fabric shall be insect, rodent, mildew, ultraviolet and rot resistant. The fabric shall be furnished in a wrapping, which will protect the fabric from abrasion due to shipping and handling. The geotextile fabric is to be kept dry until it is installed.

Posts from filter fences shall be wooden with a minimum length of 4 feet. The posts shall be of sufficient strength and size to resist damage during installation and to support applied loads.

The geotextile fabric will be reinforced with an industrial polypropylene netting with a mesh spacing not to exceed 1.5 inches. A heavy-duty nylon top support cord or equivalent shall be required.

3. INSTALLATION

The height of the barrier shall not exceed 36 inches above the ground. The fabric shall be purchased in a continuous roll, cut to the length of the barrier to avoid the use of joints. When joints are necessary, filter cloth shall be spliced together only at a support post, with a minimum twenty-four inch overlap and securely sealed.

A trench shall be excavated a minimum of six inches deep by six inches wide to bury and to anchor the geotextile fabric. The material shall be folded to fit the trench and backfilled with compacted soil to the existing ground line. The filter fabric shall be stapled or wired to the fence and/or posts. Sleeve packets for attaching filter fabric to posts are permissible.

4. INSPECTION AND MAINTENANCE

The contractor shall inspect all silt fences immediately after each rainfall and at least once daily during prolonged rainfall. Any required repairs shall be made immediately. Additional silt fences may be installed as approved by the Government.

Should the fabric decompose or become ineffective prior to the end of the expected usable life and the barrier is still necessary, the fabric shall be replaced promptly.

Sediment deposits should be removed after each storm event. Sediment shall be removed when the deposit reaches approximately one half the height of the barrier unless otherwise approved by the Government. The sediment deposits shall be disposed of in the designated areas.

5. REMOVAL

The silt fence shall not be removed until the area is topsoiled, seeded and mulched and further erosion from the work area is not likely to occur. Silt fences removed shall remain the property of the contractor and shall not be disposed of within the construction area.

Any sediment deposits remaining in place after the silt fence is no longer required shall be dressed to conform with the existing grade, prepared and seeded.

6. MEASUREMENT AND PAYMENT

Items of work for which specific unit prices are established in the contract, the quantity of silt fence installed, as specified in the construction details, will be determined to the nearest linear foot. Payment for the silt fence shall be made at the contract unit price. Such payment will be considered full compensation for all labor, materials, equipment, maintenance, removal and other items necessary and incidental to the completion of the work.

7. ITEM OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

a. Bid Item 22, Silt Fence

(1) This item shall consist of furnishing, maintaining and removal of silt fences to control pollution as shown on the drawings.

MATERIAL SPECIFICATION

300C. ROCK FOR RIPRAP

1. SCOPE

This specification covers the quality of rock to be used in the construction of rock riprap.

2. QUALITY

Individual rock fragments shall be dense, sound and free from cracks, seams and other defects conducive to accelerated weathering. Except as otherwise specified the rock fragments shall be angular to subrounded in shape. The least dimension of an individual rock fragment shall be not less than one-third the greatest dimension of the fragment.

Except as otherwise provided, the rock shall be tested and shall have the following properties:

a. Bulk Specific Gravity (saturated surface-dry basis): Not less than 2.5 when tested in accordance with ASTM Method C 127 on samples prepared as described for soundness testing.

b. Absorption: Not more than 2 percent when tested in accordance with ASTM Method C 127 on samples prepared as described for soundness testing.

c. Soundness: The weight loss in 5 cycles shall be not more than 10 percent when sodium sulfate is used or more than 15 percent when magnesium sulfate is used when tested in accordance with ASTM Method C 88 for coarse aggregate modified as follows:

The test sample shall consist of 5000 $\pm$ 300 grams of rock fragments, reasonably uniform in size and cubical in shape and weighing, after sawing, approximately 100 grams each. They shall be obtained from rock samples that are representative of the total rock mass, as noted in ASTM Practice D 4992, and that have been sawed into slabs as described in ASTM Practice D 5121. The samples shall further be reduced in size by sawing the slabs into cubical blocks. The thickness of the slabs and the size of the sawed fragments shall be determined by the size of the available test apparatus and as necessary to provide, after sawing, the approximate 100 gram samples.

Due to internal defects, some of the cubes may break during the sawing process or during the initial soaking period. Do not test any of the cubes that break during these preparatory processes. Such breakage, including an approximation of the percentage of cubes that break, shall be noted in the report.

After the sample has been dried, following completion of the final test cycle and washed to remove the sodium sulfate or magnesium sulfate, the loss of weight shall be determined by subtracting from the original weight of the sample the final weight of all fragments which have not broken into three or more pieces.

The report shall show the percentage loss of the weight and the results of the qualitative examination.

d. Rock Slab Soundness: When specified, the rock shall also be tested in accordance with ASTM D 5240, Standard Test Method for Testing Rock Slabs to Evaluate Soundness of Riprap by Use of Sodium Sulfate or Magnesium Sulfate. Unless otherwise specified, the average percent weight loss shall not exceed 20 percent when sodium sulfate is used or 25 percent when magnesium sulfate is used.

Rock that fails to meet the requirements stated above in a, b, c, or d (if specified), may be accepted only if similar rock from the same source has been demonstrated to be sound after 5 years or more of service under conditions of weather, wetting and drying, and erosive forces similar to those anticipated for the rock to be installed under this specification.

3. GRADING

The rock shall conform to the specified grading limits after it has been placed in the riprap.

MATERIAL SPECIFICATION

521. AGGREGATES FOR DRAINFILL AND FILTERS

1. SCOPE

This specification covers the quality of mineral aggregates for the construction of drainfill and filters.

2. QUALITY

Drainfill and filter aggregates shall be sand, gravel or crushed stone or mixtures thereof. Aggregates shall be composed of clean, hard, durable mineral particles free from organic matter, clay balls, soft particles or other substances that would interfere with the free-draining properties of the aggregates.

Coarse aggregate may be crushed limestone or other materials with limestone particles included. Aggregates from crushed limestone shall be thoroughly washed and screened to remove limestone dust, limestone fines, and fine soil particles. For coarse aggregate containing limestone, the total portion finer than the No. 4 sieve shall not contain more than three (3) percent by weight of limestone. Limestone shall not be used for fine aggregates except in combination with other materials such that not more than five (5) percent of the portion finer than the No. 4 sieve shall be limestone.

Aggregates shall be tested for soundness according to ASTM Method C 88, and shall have a weighted average loss in five (5) cycles of not more than twelve (12) percent when sodium sulfate is used or eighteen (18) percent when magnesium sulfate is used.

3. GRADING

Drainfill and filter aggregates shall conform to the specified grading limits after being placed or after being compacted when compaction is specified. Grading shall be determined by ASTM Method C 136. The percentage of material finer than the No. 200 sieve shall be determined by the method in ASTM Designation C 117.

4. STORING AND HANDLING

Drainfill and filter aggregates shall be stored and handled by methods that prevent segregation of particle sizes or contamination by mixing with other materials.

MATERIAL SPECIFICATION

522. AGGREGATES FOR PORTLAND CEMENT CONCRETE

1. SCOPE

This specification covers the quality of fine aggregate and coarse aggregate for use in the manufacture of portland cement concrete.

2. QUALITY

Aggregate shall conform to the requirements of ASTM Specification C 33 for the specified sizes. Aggregates that fail to meet any requirement may be accepted only when: (1) the specified alternate conditions of acceptance can be proven prior to the use of the aggregates on the job and within a period of time such that no work under the contract will be delayed by the requirements of such proof; or, (2) the specification for concrete expressly contains a provision of special mix requirements to compensate for the effects of the deficiencies.

3. REACTIVITY WITH ALKALIES

The potential reactivity of aggregates with the alkalies in cement shall be evaluated by petrographic examination and, where applicable, the chemical method of test, ASTM Designation C 289, or by the results of previous tests or service records of concrete made from similar aggregates from the same source. The standards for evaluating potential reactivity shall be as described in ASTM Specification C 33, Appendix A1.

Aggregates indicated by any of the above to be potentially reactive shall not be used, except under one of the following conditions:

a. Applicable test results of mortar bar tests, made according to ASTM Method C 227, are available which indicate an expansion of less than 0.10 percent at six (6) months in mortar bars made with cement containing not less than 0.8 percent alkalies expressed as sodium oxide; or

b. Concrete made from similar aggregates from the same source has been demonstrated to be sound after three (3) years or more of service under conditions of exposure to moisture and weather similar to those anticipated for the concrete under these specifications.

Aggregates indicated to be potentially reactive, but within acceptable limits as determined by mortar bar test results or service records, shall be used only with “low alkali” cement, containing less than 0.60 percent alkalies expressed as sodium oxide.

4. STORING AND HANDLING

Aggregates of each class and size shall be stored and handled by methods that prevent segregation of particles sizes or contamination by intermixing with other materials.

MATERIAL SPECIFICATION

531. PORTLAND CEMENT

1. SCOPE

This specification covers the quality of portland cement.

2. QUALITY

Portland cement shall conform to the requirements of ASTM Specification C 150 for the specific types of cement. When Type I portland cement is specified, Type IS portland blast-furnace slag cement or Type IP portland-pozzolan cement conforming to the requirements of ASTM Specification C 595 may be used unless prohibited by the specifications.

When air-entraining cement is required, the Contractor shall furnish the manufacturer's written statement providing the source, amount and brand name of the air-entraining component.

3. STORAGE AT THE CONSTRUCTION SITE

Cement shall be stored and protected at all times from weather, dampness or other destructive elements. Cement that is partially hydrated or otherwise damaged will not be accepted.

MATERIAL SPECIFICATION

532. MINERAL ADMIXTURES FOR CONCRETE

1. SCOPE

This specification covers the quality of mineral admixtures for concrete.

2. QUALITY

Fly ash used as a partial substitution of portland cement shall conform to the requirements of ASTM C 618, Class C or F except the loss on ignition shall not exceed three (3) percent, unless otherwise specified. Lot-to-lot variation in the loss on ignition shall not exceed one (1) percent.

Blast-furnace slag used as a partial substitution of portland cement shall conform to ASTM Standard C 989 for ground granulated blast-furnace slag.

MATERIAL SPECIFICATION

533. CHEMICAL ADMIXTURES FOR CONCRETE

1. SCOPE

This specification covers the quality of chemical admixtures for manufacturer of portland cement concrete.

2. QUALITY

Air-entraining admixtures shall conform to the requirements of ASTM Specification C 260.

Water-reducing and/or retarding admixtures shall conform to the requirements of ASTM Specification C 494, Types A, B, D, F, or G.

Plasticizing or plasticizing and retarding admixtures shall conform to ASTM Specification C 1017.

Accelerating or water-reducing and accelerating admixtures shall be non-corrosive and conform to the requirements of ASTM Specification C 494, Types C and E. The manufacturer shall provide long-term test data results from an independent laboratory verifying that the product is non-corrosive when used in concrete exposed to continuously moist conditions.

MATERIAL SPECIFICATION

534. CONCRETE CURING COMPOUND

1. SCOPE

This specification covers the quality of liquid membrane-forming compounds suitable for spraying on concrete surfaces to retard the loss of water during the concrete curing process.

2. QUALITY

The curing compound shall meet the requirements of ASTM Specification C 309.

Unless otherwise specified, the compound shall be Type 2.

3. DELIVERY AND STORAGE

All curing compound shall be delivered to the site of the work in the original container bearing the name of the manufacturer and the brand name. The compound shall be stored in a manner that prevents damage to the container and protects water-emulsion types from freezing.

MATERIAL SPECIFICATION

535. PREFORMED EXPANSION JOINT FILLER

1. SCOPE

This specification covers the quality of preformed expansion joint fillers for concrete.

2. QUALITY

Preformed expansion joint filler shall conform to the requirements of ASTM Specification D 1752, Type I, Type II, or Type III, unless bituminous type is specified. Bituminous type preformed expansion joint filler shall conform to the requirements of ASTM Specification D 994, or D 1751.

MATERIAL SPECIFICATION

536. SEALING COMPOUND FOR JOINTS IN CONCRETE AND CONCRETE PIPE

1. SCOPE

This specification covers the quality of sealing compound for filling joints in concrete pipe and concrete structures.

2. TYPE

The compound shall be a cold-application material, unless otherwise specified, and shall be a single component or multiple component type.

3. QUALITY

The sealing compound shall conform to the requirements of one of the following specifications:

ASTM Specification C 990; Joints for Concrete Pipe, Manholes, and Pre-cast Box Sections using Pre-formed Flexible Joint Sealants.

ASTM Specification C 877; External Sealing Bands for Non-Circular Concrete Sewer, Storm Drain, and Culvert Pipe.

ASTM Specification D 1190; Concrete Joint Sealer, Hot Poured Elastic Type.

ASTM Specification C 920; Elastomeric Joint Sealants for cold applied sealing and caulking of joints on mortar and concrete structures not subject to fuel spills. Use Type S or M, Grade NS for vertical joints; Type S or M, Grade P or NS for horizontal joints. Class 25, Use M, quality materials shall be used for both vertical and horizontal joints unless otherwise specified.

The sealing compound, if used with other joint materials, such as fillers or gaskets, shall be compatible.

MATERIAL SPECIFICATION

539. STEEL REINFORCEMENT (FOR CONCRETE)

1. SCOPE

This specification covers the quality of steel reinforcement for reinforced concrete.

2. QUALITY

All reinforcement shall be free from loose or flaky rust, soil, oil, grease, paint or other deleterious matter.

Steel bars for concrete reinforcement shall be Grade 40, 50, or 60 deformed bars conforming to one of the following specifications:

Deformed and Plain Billet-Steel Bars for Concrete Reinforcement - ASTM A 615

Rail-Steel Deformed and Plain Bars for Concrete Reinforcement - ASTM A 616 with the S1 supplemental requirements

Axle-Steel Deformed and Plain Bars for Concrete Reinforcement - ASTM A 617.

Dowels shall be plain round bars conforming to the same specifications listed above for steel bars.

Fabricated deformed steel bar mats for concrete reinforcement shall conform to the requirements of ASTM A 184.

Plain steel welded wire fabric for concrete reinforcement shall conform to the requirements of ASTM A 185.

Deformed steel welded wire fabric for concrete reinforcement shall conform to the requirements of ASTM A 497.

Epoxy-coated steel bars for concrete reinforcement shall conform to the requirements of ASTM A 775.

3. DIMENSIONS OF WELDED WIRE FABRIC

Gauges, diameters, spacing and arrangement of wires for welded steel wire fabric shall be as defined for the specified style designations.

4. STORAGE

Steel reinforcement inventories at the site of the work shall be stored above the ground surface on platforms, skids or other supports and shall be kept clean and protected from mechanical injury and corrosion.

MATERIAL SPECIFICATION

541. REINFORCED CONCRETE PRESSURE PIPE

1. SCOPE

This specification covers the quality of reinforced concrete pressure pipe and fittings.

2. MANUFACTURE AND FABRICATION

The pipe, the materials used in its manufacture, and the methods of fabrication shall conform to the requirements of the following specifications applicable to the specified type of pipe.

a. Steel Cylinder Type, Pre-stressed: AWWA Standard C301 for Pre-stressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids.

b. Steel Cylinder Type, Not Pre-stressed: AWWA Standard C300 for Reinforced Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids.

c. Non-cylinder Type, Not Pre-stressed: AWWA Standard C302 for Reinforced Concrete Pressure Pipe, Non-cylinder Type, for Water and Other Liquids.

d. Steel Cylinder Type, Pre-tensioned: AWWA Standard C303 for Concrete Pressure Pipe, Bar-Wrapped, Steel Cylinder Type for Water and Other Liquids.

e. Low Head Pressure Pipe: ASTM Specification C 361.

The following Specification Sections shall not apply:

AWWA C300 and C301, Sections 1.5 and 1.6.
AWWA C302 and C303, Sections 4.2 and 4.3.

3. DESIGN

The actual pipe and fittings shall be designed by the manufacturer to withstand the specified external loads and internal pressures. Designs shall be by either of the following methods as applicable to the type of pipe specified:

a. Indirect Design: ASTM C497 for Standard Test Method for Concrete Pipe, Manhole Sections, or Tile.

Pipe design shall be based on the results of external crushing strength tests on a minimum two-foot length of the pipe or a specimen of equivalent size, design, and materials. The test shall demonstrate the following bearing loads:

(1) For pipe manufactured according to ASTM C361, AWWA C300, or AWWA C302, the load required to produce a 0.01-inch crack on foot long.

(2) For pipe manufactured according to ASTM C301, the load required to produce a 0.001-inch crack one foot long that is 10-percent greater than the specified three-edge bearing strength, whichever is lower.

In lieu of actual testing for this contract, pipe design may be based on Design Curve previously approved and published by the Natural Resources Conservation Service (formerly the Soil Conservation Service).

b. Direct Design: AWWA C304 for Design of Prestressed Concrete Cylinder Pipe or AWWA Manual M9 for Concrete Pressure Pipe.

Pipe design shall be based on structural analysis and design calculations.

c. Standard Design: ASTM C361 for Reinforced Concrete Low Head Pressure Pipe.

Pipe design shall be as published in the standard.

4. STEEL REINFORCEMENT

The steel reinforcements shall conform to the requirements of the specifications cited in Section 2 for the specified type of pipe, except that elliptical reinforcing cages or other reinforcements that require special orientation of the pipe during placement will not be allowed.

5. JOINTS

The pipe joints shall conform to the requirements of the applicable specification for the pipe. They shall be bell-and-spigot type or double-spigot-and-sleeve type and shall have a positive groove in the spigot to contain the rubber gasket. The size and shape of the groove shall be such that it will prevent displacement of the gasket by either internal or external water pressure when the joint is in any position within the required range of movement capability. Joint sleeves, also referred to as "collars" or "coupling bands," shall conform to the requirements for bell rings in the applicable pipe specification.

The joints shall be constructed so as to permit relative movement of the adjoining pipe sections with no reduction of watertightness. The joint length and the limiting angle defining the required capability of relative movement at each joint shall be no less than specified.

Joint length refers to the permissible axial movement in the joint, and is defined as the maximum distance through which the spigot can move, relative to the bell or sleeve, from the fully engaged to the fully extended condition of the joint when the adjoining pipe sections are in parallel, concentric alignment. The joint is considered to be fully engaged when the spigot is inserted as far as it will go into the bell or sleeve, and fully extended when it is inserted the least amount that will ensure full confinement of the gasket and complete watertightness.

Joint length specified for double-spigot joints refers to the permissible movement in each of the spigot-to-sleeve connections, not the sum of the two.

The limiting angle of the joint is defined as the maximum deflection angle between adjoining pipe sections the joint will permit before the outer surface of the spigot comes into direct contact with inside of the mating bell or sleeve. If both spigot-to-sleeve connections of a double-spigot joint permit angular movement, the limiting angle of the joint is the sum of the two deflection angles permitted by the two connections.

6. GASKETS

The pipe joint gaskets shall conform to the requirements of the specifications cited in Section 2 of this specification. They shall be endless rubber gaskets having circular cross section. The cross-sectional diameter of the gaskets shall conform to the pipe manufacturer's recommendation for the type and size of pipe furnished.

7. MARKING

All pipe sections and special fittings shall be marked by the manufacturer with the manufacturer's name or trademark, the date of manufacture, the nominal size, design head, design external load and the structure site for which it was designed and manufactured.

8. CERTIFICATION

All component materials and actual pipe fabrication shall be tested, inspected, and documented as prescribed in the manufacturing specifications for the type of pipe specified. All documentation a noted in the manufacturing specifications shall be submitted to the Engineer. Documentation shall include current test reports on steel and steel wire reinforcing and compression tests of concrete used in the manufacture of the furnished pipe.

For pipe design based on actual external crushing strength tests, the Engineer shall witness the actual test.

For pipe design based on published Design Curves, a copy of the appropriate design curve marked to show the resultant concrete core stress and corresponding three-edge bearing load, and a specification sheet showing all data and dimensions necessary to calculate the resultant core stress, for the pipe furnished shall be submitted to the Engineer.

For pipe design based on structural analysis and calculations, such analysis and calculations shall be submitted to the Engineer. Printouts of such calculations by computer programs shall be sufficiently detailed to enable comparison with standardized procedures and methods.

Drawings, details, and descriptions of the pipe joints as necessary to show that the joint conforms to the specified requirements shall also be submitted.

MATERIAL SPECIFICATION

547. PLASTIC PIPE

1. SCOPE

This specification covers the quality of Poly Vinyl Chloride (PVC), Polyethylene (PE), High Density Polyethylene (HDPE), and Acrylonitrile-Butadiene-Styrene (ABS) plastic pipe, fittings and joint materials.

2. MATERIALS

a. Pipe

The pipe shall be as uniform as commercially practicable in color, opaqueness, density, and other specified physical properties and free from visible cracks, holes, foreign inclusions, or other defects. The dimensions of the pipe shall be measured as prescribed in ASTM D 2122.

Unless otherwise specified, the pipe shall conform to the requirements listed in this specification and the applicable reference specifications in Table 547-2, the requirements specified in Construction Specification 45, Plastic Pipe, and the requirements shown on the drawings.

b. Fittings and Joints

Fittings and joints shall be of a schedule, SDR or DR, pressure class, external load carrying capacity, or pipe stiffness that equals or exceeds that of the plastic pipe. The dimensions of fittings and joints shall be compatible with the pipe and measured in accordance with ASTM D 2122. Joint and fitting material shall be compatible with the pipe material. The joints and fittings shall be as uniform as commercially practicable in color, opaqueness, density, and other specified physical properties and free from visible cracks, holes, foreign inclusions, or other defects.

Fittings and joints shall conform to the requirements listed in this specification, the requirements of the applicable specification referenced in the ASTM or AWWA specification for the pipe, the requirements specified in Construction Specification 45, and the requirements shown on the drawings.

c. Solvents

Solvents for solvent welded pipe joints shall be compatible with the plastic pipe used and shall conform to the requirements of the applicable specification referenced in the ASTM or AWWA specification for the pipe, fitting, or joint.

d. Gaskets

Rubber gaskets for pipe joints shall conform to the requirements of ASTM F 477, Elastomeric Seals (Gaskets) for Jointing Plastic Pipe.

3. PERFORATIONS

When perforated pipe is specified, perforations shall conform to the following requirements, unless otherwise specified in Construction Specification 45 or shown on the drawings:

a. Perforations shall be either circular or slots.

b. Circular perforations shall be 1/4 ± 1/16-inch diameter holes arranged in rows parallel to the axis of the pipe. Perforations shall be evenly spaced along each row such that the center-to-center distance between perforations is not less than eight (8) times the perforation diameter. Perforations may appear at the ends of short and random lengths. The minimum perforation opening per foot of pipe shall be as shown in Table 547-1.

Rows shall be arranged in two (2) equal groups at equal distance from the bottom on each side of the vertical centerline of the pipe. The lowermost rows of perforations shall be separated by an arc of not less than 60° or more than 125°. The uppermost rows of perforations shall be separated by an arc not to exceed 166°. The spacing of rows between these limits shall be uniform. The minimum number of rows shall be as shown in Table 547-1.

c. Slot perforations shall be symmetrically located in two (2) rows, one on each side of the pipe centerline. Slot perforations shall be located within the lower quadrants of the pipe with slots no wider than 1/8 inch and spaced not to exceed 11 times the perforation width. Minimum perforation opening per lineal foot of pipe shall be as shown in Table 547-1.

TABLE 547-1
PERFORATIONS

Nominal Pipe Size (Inches)	Minimum Number of Rows		Minimum Opening/Foot (Square Inches)
	Circular	Slot	
4	2	2	0.22
6	4	2	0.44
8	4	2	0.44
10	4	2	0.44
12	6	2	0.66

d. On both the inside and outside of the pipe, perforations shall be free of cuttings or frayed edges, and any materials that would reduce the effective opening.

TABLE 547-2
PIPE SPECIFICATION

POLY VINYL CHLORIDE (**PVC**) PIPE	SPECIFICATION
Plastic Pipe - Schedules 40, 80, 120	ASTM D 1785 ASTM D 2466
Pressure Rated Pipe - SDR Series	AWWA C 900 ASTM D 2241
Plastic Drain, Waste, and Vent Pipe and Fittings	ASTM D 2665
Joints for IPS PVC Pipe Using Solvent Weld Cement	ASTM D 2672
Composite Sewer Pipe	ASTM D 2680
Type PSM PVC Sewer Pipe and Fittings	ASTM D 3034
Large-Diameter Gravity Sewer Pipe and Fittings	ASTM F 679
Smooth-Wall Underdrain Systems for Highway, Airport, and Similar Drainage	ASTM F 758
Type PS-46 Gravity Flow Sewer Pipe and Fittings	ASTM F 789
Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter	ASTM F 794
Corrugated Sewer Pipe With a Smooth Interior and Fittings	ASTM F 949
Pressure Pipe, 4-inch through 12-inch for Water Distribution	AWWA C 900
Water Transmission Pipe, Nominal Diameters 14-inch through 36-inch	AWWA C 905

TABLE 547-2 (CONTINUED)
PIPE SPECIFICATIONS

POLYETHYLENE (**PE**) PLASTIC PIPE	SPECIFICATION
Schedule 40	ASTM D 2104
SIDR-PR Based on Controlled Inside Diameter	ASTM D 2239
Schedules 40 and 80 Based on Outside Diameter	ASTM D 2447
SDR-PR Based on Controlled Outside Diameter	ASTM D 3035

HIGH DENSITY POLYETHYLENE (**HDPE**) PLASTIC PIPE	SPECIFICATION
Plastic Pipe and Fittings	ASTM D 3350
SDR-PR Based on Controlled Outside Diameter	ASTM F 714
Plastic Moldings and Extrusion Compounds	ASTM D 1248
Heat Joining Polyolefin Pipe and Fittings	ASTM D 2657

ACRYLONITRILE-BUTADIENE-STYRENE (**ABS**) PIPE	SPECIFICATION
Plastic Pipe, Schedules 40 and 80	ASTM D 1527
Plastic Pipe, SDR-PR	ASTM D 2282
Schedule 40 Plastic Drain, Waste, and Vent Pipe	ASTM D 2661
Composite Sewer Pipe	ASTM D 2680
Sewer Pipe and Fittings	ASTM D 2751

MATERIAL SPECIFICATION

581. METAL

1. SCOPE

This specification covers the quality of steel and aluminum alloys.

2. STRUCTURAL STEEL

Structural steel shall conform to the requirements of ASTM A 36.

High-strength low-alloy structural steel shall conform to ASTM A 242 or A 588.

Carbon steel plates of structural quality to be bent, formed, or shaped cold shall conform the ASTM A 283, Grade C.

Carbon steel sheets of structural quality shall conform to ASTM Standard A 570, Grade D or A 611, Grade D.

Carbon steel strip of structural quality shall conform to ASTM Standard A 570, Grade C.

3. COMMERCIAL OR MERCHANT QUALITY STEEL

Commercial or merchant quality steel shall conform to the requirements of the applicable ASTM listed below:

Product	ASTM Standards
Carbon steel bars	A 575, Grade M 1015 to Grade M 1031
Carbon steel sheets	A 569
Carbon steel strips	A 569
Zinc-coated carbon steel sheets	A 653 or A 924

4. ALUMINUM ALLOY

Aluminum alloy products shall conform to the requirements of the applicable ASTM Standard listed below. Unless otherwise specified, alloy 6061-T6 shall be used.

Product	ASTM Standard
Standard Structural Shape	B 308
Extruded structural pipe and tube	B 429
Extruded bars, rods, shapes and tubes	B 221
Drawn seamless tubes	B 210
Rolled or cold-finished bars, rods and wire	B 211
Sheet and plate	B 209

5. BOLTS

Steel bolts shall conform to the requirements of ASTM Standard A 307. If high-strength bolts are specified, they shall conform to the requirements of ASTM A 325.

When galvanized or zinc-coated bolts are specified, the zinc coating shall conform to the requirements of ASTM Standard A 153; except that bolts 1/2 inch or less in diameter may be coated with electro-deposited zinc or cadmium coating conforming to the requirements of ASTM Standard B 633, Service Condition SC 3 or ASTM A 165, Type TS, unless otherwise specified.

6. RIVETS

Unless otherwise specified, steel rivets shall conform to the requirements of ASTM Specification A 502, Grade 1. Unless otherwise specified, aluminum alloy rivets shall be Alloy 606-T6 conforming to the requirements of ASTM Standard B 316.

7. WELDING ELECTRODES

Steel welding electrodes shall conform to the requirements of American Welding Society Specification AWS A5.1, "Specification for Mild Steel Covered Arc-Welding Electrodes," except that they shall be uniformly and heavily coated (not washed) and shall be of such a nature that the coating will not chip or peel while being used with the maximum amperage specified by the manufacturer.

Aluminum welding electrodes shall conform to the requirements of American Welding Society Specification AWS A5.10, "Specification for Aluminum and Aluminum-Alloy Welding Rods and Bare Electrodes."

MATERIAL SPECIFICATION

582. GALVANIZING

1. SCOPE

This specification covers the quality of zinc coatings applied to iron and steel productions.

2. QUALITY

Zinc coatings shall conform to the requirements of ASTM A 123 for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products or as otherwise specified in the items of work and construction details of the Construction Specification.

ASTM A 123 covers both fabricated and non-fabricated products e.g., assembled steel products, structural steel fabrications, large tubes already bent or welded before galvanizing, and wire work fabricated from non-coated steel wire. It also covers steel forgings and iron castings incorporated into pieces fabricated before galvanizing or which are too large to be centrifuged (or otherwise handled to remove excess galvanizing bath metal). Items to be centrifuged or otherwise handled to remove excess zinc shall meet the requirements of ASTM A 153, except: bolts, screws and other fasteners 1/2-inch or less in diameter may be coated with electro-deposited zinc or cadmium coating conforming to the requirements of ASTM B 766, coating thickness Class 5, Type III or ASTM B 633, Service Condition SC-3 unless otherwise specified.

MATERIAL SPECIFICATION

592. GEOTEXTILE

1. SCOPE

This specification covers the quality of geotextiles.

2. GENERAL REQUIREMENTS

Fibers (threads and yarns) used in the manufacture of geotextile shall consist of synthetic polymers composed of a minimum of 85 percent by weight polypropylenes, polyesters, polyamides, polyethylene, polyolefins, or polyvinylidene-chlorides. They shall be formed into a stable network of filaments or yarns retaining dimensional stability relative to each other. The geotextile shall be free of defects and conform to the physical requirements contained in Tables 1 and 2. The geotextile shall be free of any chemical treatment or coating that significantly reduces its porosity. Fibers shall contain stabilizers and/or inhibitors to enhance resistance to ultraviolet light.

Thread used for factory or field sewing shall be of contrasting color to the fabric and made of high strength polypropylene, polyester, or polyamide thread. Thread shall be as resistant to ultraviolet light as the geotextile being sewn.

3. CLASSIFICATION

Geotextiles shall be classified based on the method used to place the threads or yarns forming the fabric. The geotextiles will be grouped into the types described below:

a. Woven. Fabrics formed by the uniform and regular interweaving of the threads or yarns in two directions.

Woven fabrics shall be manufactured from monofilament yarn formed into a uniform pattern with distinct and measurable openings, retaining their position relative to each other. The edges of fabric shall be selvedged or otherwise finished to prevent the outer yarn from unraveling.

b. Non-woven. Fabrics formed by a random placement of threads in a mat and bonded by heat-bonding, resin-bonding, or needle punching.

Non-woven fabrics shall be manufactured from individual fibers formed into a random pattern with distinct but variable small openings, retaining their position relative to each other when bonded by needle punching, heat, or resin bonding. The use of non-wovens, other than the needle punched geotextiles, is somewhat restricted (see Note 3 of Table 2).

4. SAMPLING AND TESTING

The geotextile shall meet the specified requirements (Table 1 or 2) for the product style shown on the label. Product properties as listed in the lastest edition of the "Specifiers Guide", Geotechnical Fabrics Report, ADDRESS: Industrial Fabrics Association International, 1801 County Road BW, Roseville, MN 55113-4061; and that represents minimum average roll values, will be acceptable documentation that the product style meets the requirements of these specifications.

For products that do not appear in the above directory, or do not have minimum average roll values listed, typical test data from the identified production run of the geotextile will be required for each of the specified tests (Table 1 or 2) as covered under clause AGAR 452.236-76.

5. SHIPPING AND STORAGE

The geotextile shall be shipped/transported in rolls wrapped with a cover for protection from moisture, dust, dirt, debris, and ultraviolet light. The cover shall be maintained undisturbed to the maximum extend possible prior to placement.

Each roll of geotextile shall be labeled or tagged to clearly identify the brand, Class and the individual production run in accordance with ASTM D 4873.

TABLE 1. REQUIREMENTS FOR WOVEN GEOTEXTILES

Property	Test Method	Class I	Class II & III	Class IV
Tensile Strength (pounds) 1/	ASTM D 4632 Grab Test	200 minimum in any principal direction	120 minimum in any principal direction	180 min. in any principal direction
Bursting Strength (psi) 1/	ASTM D 3786 Diaphragm Tester	400 minimum	300 minimum	NA
Elongation at Failure (percent) 1/	ASTM D 4632 Grab Test	<50	<50	<50
Puncture (pounds) 1/	ASTM D 4833	90 minimum	60 minimum	60 minimum
Ultraviolet Light (percent residual tensile strength)	ASTM D 4355 150-hours exposure	70 minimum	70 minimum	70 minimum
Apparent Opening Size (AOS)	ASTM D 4751	As specified or a minimum # 100 2/	As specified or a minimum # 100 2/	As specified or minimum # 100 2/
Percent Open Area (percent)	CWO-02215-86	4.0 minimum	4.0 minimum	1.0 minimum
Permitivity sec^{-1}	ASTM D 4491	0.10 minimum	0.10 minimum	0.10 min.

1/ Minimum average roll value (weakest principal direction).

2/ U. S. Standard Sieve Size.

NOTE: CWO is a USACE reference.

TABLE 2. REQUIREMENTS FOR NON-WOVEN GEOTEXTILES

Property	Test Method	Class I	Class II	Class III	Class IV 3/
Tensile Strength (pounds) 1/	ASTM D 4632 Grab Test	180 minimum	120 minimum	90 minimum	115 min.
Bursting Strength (psi) 1/	ASTM D 3786 Diaphragm Tester	320 minimum	210 minimum	180 minimum	NA
Elongation at Failure (percent) 1/	ASTM D 4632	≥50	≥50	≥50	≥50
Puncture (pounds)	ASTM D 4833	80 minimum	60 minimum	40 minimum	40 minimum
Ultraviolet Light (percent residual tensile strength)	ASTM D 4355 150-hours exposure	70 minimum	70 minimum	70 minimum	70 minimum
Apparent Opening Size (AOS)	ASTM D 4751	As specified max. # 40 2/	As specified max. # 40 2/	As specified max. # 40 2/	As specified max. # 40 2/
Permittivity sec^{-1}	ASTM D 4491	0.70 minimum	0.70 minimum	0.70 minimum	0.10 min.

1/ Minimum average roll value (weakest principal direction)

2/ U. S. Standard Sieve Size.

3/ Heat-bonded or resin-bonded geotextile may be used for Class III and IV. They are particularly well suited for Class IV. Needle-punched geotextiles are required for all other classes.